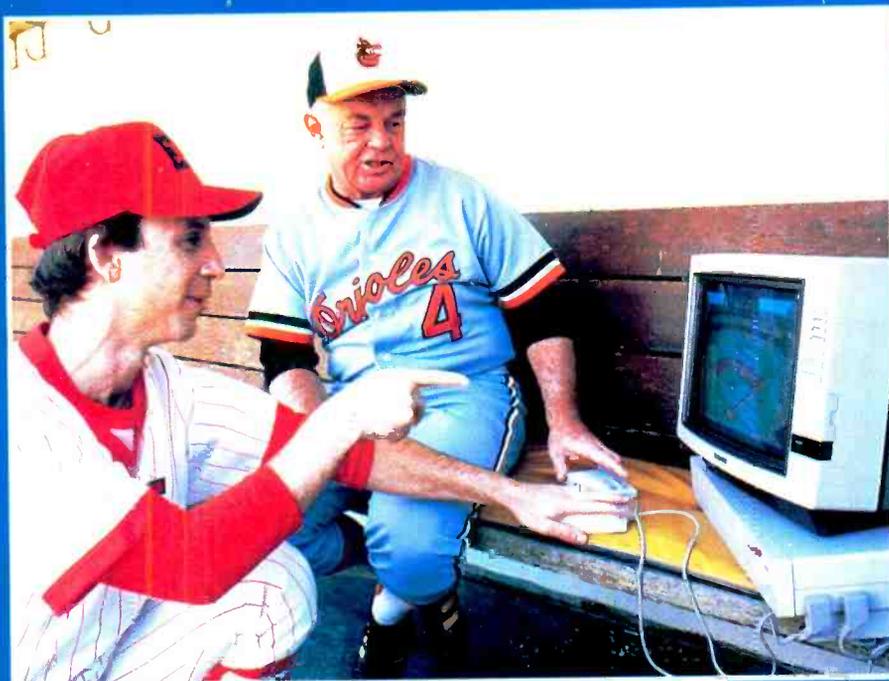


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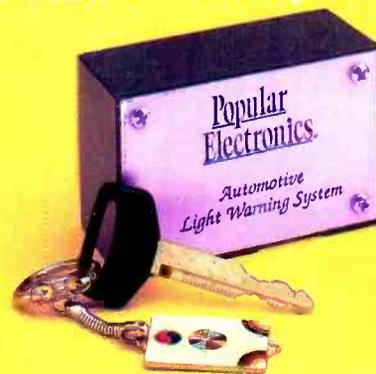
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HOME IS A MAN'S CASTLE!

Once upon a time, there was a sharp line between a man's work and his private life. When he left the office, shop, store, or factory, he stepped into his private life. The trip home may have been a sort of twilight zone where thoughts of work and home mingled, but once he stepped into his house, that was it as far as his working life went.

The other day I was watching a softball game in a local playground when the guy I was chatting with went "Beep...Beep...Beep!" Not him, actually, but his pocket pager. He left quickly, looking for a nearby public telephone.

These days, it's not unusual to see some chap on the highway chatting into his cellular telephone. Electronics communication now reaches into the car, and even the playground, to rob us of some of our very precious private lives.

Now, with the coming of the FAX machine, the next wave of electronic's assault on our privacy has landed. A friend installed a FAX machine at home so that his clients in Asia can reach him during their working hours. Now he is waking up in the middle of the night to check his FAX machine for mail, and replying during the wee hours.

Even those of us that have no need for the cutting edge in electronics gadgetry can't escape completely unscathed. I received a pocket electronic organizer for Christmas. Nice gadget: It keeps my appointments, phone numbers, memos; is a great calculator; and more. But I really could have lived without the buzzer alarm.

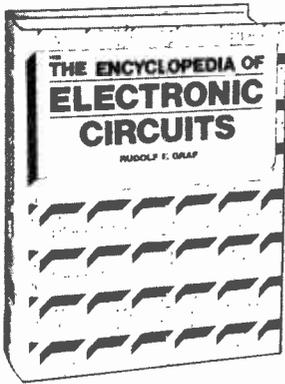
The pay off came today. Since I do a lot of work at home, I have three telephone lines and several phones throughout the house. When I stepped in the door, my wife informed me that she had surveyed the layout and learned that for the price of a few more phones and some wiring, we could have a telephone in every room in the house, and I mean every room in the house. Enough is enough!

Home is a man's castle!

Julian S. Martin, KA2GUN
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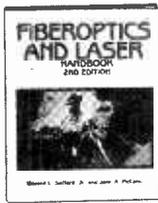
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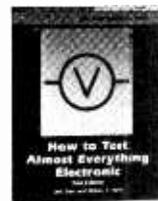
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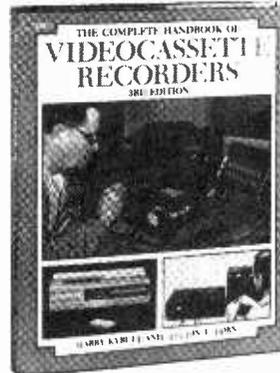
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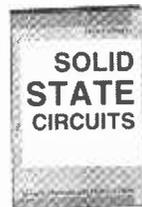
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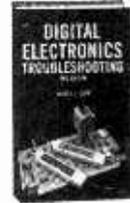
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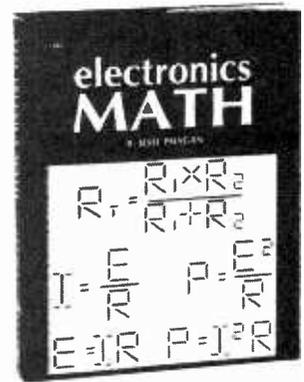


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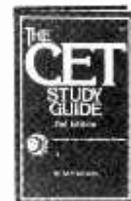
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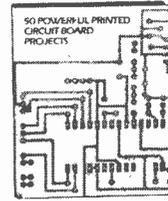
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Letters

LET THERE BE LIGHTNING

We have been informed that the Q4004 quad-rac used in the "Lightning Bulb" article (*Popular Electronics*, February 1989) is no longer available. However, two direct replacements are available; those are the 2N6073A and the ECG 5646. In addition, as mentioned in the article, a 4-amp, 400-volt triac/diac combination may be used in place of the quadrac.

Also, the bulb (11) was listed in the Parts List as a G-400 type; it is a G-40 type, as shown in the schematic.—Editor

RADIO RECOLLECTIONS

As a new subscriber to *Popular Electronics*, I must tell you that I find things in your pages that bring back some fond memories. I have worked and hobbyed in electronics for over 50 years, at one time or another as radio repairman, short-wave listener, AM transmitter engineer, military technician, electrical engineer, and Bell equipment engineer from open wire through carrier and microwave to the beginning of fiber optics. I have repaired (and, regrettably, disassembled) many of the radios of the period now covered by your "Antique Radio" column.

Since I also qualify, several times over, as a Grandpa, I must tell you that "Grandpa's Short Wave Receiver" (*Popular Electronics*, February 1989) is functionally a close copy of my first full-size project—the "RSR Receiver" from the 1938 annual of, I believe, *Radio Craft*. That receiver was also sold commercially for a short while, although superhets already had pretty well monopolized the field. It did have the addition of super-regeneration (the "SR" in "RSR") for 10, 7 $\frac{1}{2}$, and 5 meters, which took over from the band-switched lower bands by a system of links and self-supporting coils that were shuffled among some chassis-top pinjacks.

It was a little more advanced in some ways. The lower bands did not require a tickler to each (or all) coil(s) because the later plan of a cathode tap on each coil allowed adjustment by plate voltage only to the feedback. It used a 6K7 untuned RF for the same reason as "Grandpa's," a 6J5 detector (yes, grid leak!) and another for first audio, and a 6L6 output—real speaker power there, even with a modest voltage supply. I don't remember the rectifier—80 or 5Y3, I think.

With that receiver, I logged most of the well-known pre-WWII shortwave broadcast

stations. I still have my collection of verification cards from the BBC, Radio Berlin, and the rest.

I would like to suggest a later retrofit for your receiver to allow good loudspeaker volume. Even the LM386 can serve marginally, but other common chips would be capable of more output, fully taking the place of the 6L6; I always liked the glass versions because of their cheery glow!

It is interesting to think that new experimenters might like to reproduce our simpler amusements of the past!

C.E.W.
Orlando, FL

A READER'S REQUEST

I would like to see an article on building a device that is similar to Radio Shack's Telephone Recording Control (cat. No. 43-236-B), for tapping my own phone. (How does it work?) However, I'd like to see it voice activated rather than line-voltage activated.

I would design it myself, but I don't know how to protect the audio amp in it from the very high ring voltage on the line. Can you help me out?

H.L.K.
New York, NY

Hang on for another month or two. We have a story in the works that may be just what you are looking for.

PARTS SEARCH

As a student in an electronics course at a local community college, I have been building up my own home shop, partly with instruments like the "10-MHz Frequency Counter" from the January issue of *Popular Electronics*. Our teacher requires us to build that type of project for the course, and our grades depend on them.

Another student and I both wanted to build that instrument, and we began to buy parts for it. However, we've been baffled to no end looking for the 5.24288-MHz crystal required. So far, we've located only one supplier, a manufacturer who will custom-build the crystals for us, at a substantially higher price than those in the catalogs. Another problem concerns the ICM7207A oscillator-controller. Catalogs list three different versions of the 7207A, each with the affix "AIPD" and a frequency rating. Which is the proper one?

It was a serious oversight not to include sources for those special parts in the article. They do not seem to be widely used, judging from the scarcity of catalog listings for the 7207A, and the total absence of listings for the crystal. I would very much appreciate an answer to my questions so that I can complete the project. It appears to be very well designed, and would be a real asset to any electronics technician.

Popular Electronics is widely read by the technician trainees at my school. Although they find it interesting, about half of them are skeptical of building projects from any

magazine article, due mainly to the problems encountered by those who do. You could help to remove that skepticism by requiring authors to provide more complete information.

W.P.H.
Richland, WA

As stated here in the past, we try to provide information on any parts we feel would be hard to find. At the time this article was prepared, both the IC and the crystal were relatively easy-to-find components; unfortunately, as sometimes happens, several hobbyist-oriented suppliers seem to have discontinued one or both components at the same time. One that we know of still carries both, however. That company is Circuit Specialists (P.O. Box 3047 Scottsdale, AZ 85271-3047; tel. 602/966-0764); contact them directly for pricing and shipping information. In addition, you should be able to order the crystal from any of the major crystal houses, such as Jan Crystals (P.O. Box 06017, Ft. Meyers, FL 33906; 813/936-2397) or Crystek (2351/2371 Crystal Dr., Ft. Meyers, FL 33906-6135; 813/936-2109).

We must confess, we were not aware that 7207A came in more than one variety; if we were, we would have provided a more complete specification for that unit. However, as technical students, the frequency of our elusive crystal should have tipped you off that what you need is the 5-MHz version.

FREQUENCY-COUNTER DISPLAYS

I have acquired a small stock of common-cathode, multiplexed LED displays that would be suitable for use in my project "10-MHz Frequency Counter" (January, 1989). Both units feature right-hand decimal points. One display is an 9-digit unit whose circuit board measures approximately 1 $\frac{3}{8}$ by 2 $\frac{3}{8}$ inches; there is no connection to D1 (the first digit), so the display is, in effect, an 8-digit one. The other display is a 12-digit unit whose circuit board measures approximately $\frac{3}{4}$ by 2 $\frac{3}{4}$ inches; D1 has ground and decimal-point connections only, while D12 has no decimal point. Either may be purchased for \$4.00 each, postpaid, while supplies last (buyers should include a stamped, self-addressed envelope with each order for my reply if stocks are exhausted). GA residents must add appropriate sales tax.

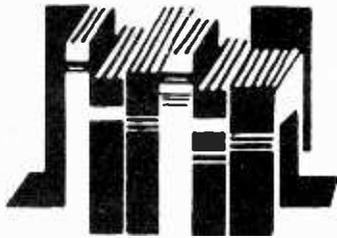
Paul W. Aman
1552 Daffodil Dr. NE
Marietta, GA 30062

HAVES AND NEEDS

I am looking for Dick Smith's *Radio Control Hobbyist's Handbook*, by Edward Safford, or a similar book that explains how to build projects to make most of my house radio controlled.

Michael J. Giamportone
7330 Duce Road
Yale, MI 48097

I have a Dumont oscilloscope (Model 440,



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TELEVISION SYMPTOM DIAGNOSIS: Third Edition

by Richard W. Tinnell
revised by Gregory R. Capelo, CET

Based on the premise that a good technician needs four basic skills—the ability to observe and recognize symptoms, an understanding of the television-receiver system, enough knowledge of electronic circuitry to be able to isolate a problem to an individual component, and the physical dexterity needed to replace parts—this book undertakes to teach beginning and intermediate technicians the first three skills. (The fourth skill will come with practice and experience.)

Rather than concentrating on complex theory, the book provides the practical information necessary to diagnose problems, locate defective parts, and get television



equipment back up and running. The third edition has been updated to include the latest high-tech televisions, with expanded troubleshooting coverage. A separate chapter is dedicated to each section of the receiver, for quick reference to specific problems. Information is reinforced by review questions at the end of each chapter, and the book is heavily illustrated with circuit diagrams, drawings, and photos.

Some of the topics covered include troubleshooting video failures, automatic gain control, audio section failures, the sound IF section, television sync problems,

picture-sweep failure and loss of the raster, custom television circuits, the black-and-white receiver, low-voltage power-supply problems, and an introduction to color television.

Television Symptom Diagnosis: Third Edition is available for \$19.95 from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

50 POWERFUL PRINTED CIRCUIT BOARD PROJECTS

by Dave Prochnow

Each of the projects in this book includes its own computer-generated photo image of the printed-circuit board, as well as full descriptions, schematic diagrams, and instructions. Using the templates and following the step-by-step directions for etching the boards can make project-building a simpler and quicker process.

The projects include a wireless microphone, a light sensor, a 6-volt battery charger, pulsing lights, an LED timer, a solar radio, and an IR communicator. Also featured are a mercury alarm, a complex speech synthesizer, an insect repeller, a roaming robot, a light alarm, a code-practice oscillator, and a random-light game. Mail-order sources for any potentially hard-to-find materials are listed, along with a parts index, selected IC data sheets, and a glossary.

50 Powerful Printed Circuit Board Projects is available for \$15.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

THE LASER COOKBOOK: 88 Practical Projects

by Gordon McComb

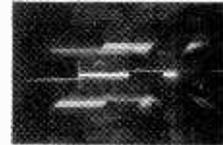
This book serves as an introduction to laser and optic technologies, and presents 88 laser-based projects. Those projects, which are geared toward the experimenter on a tight budget, go far beyond "laser tag" toys. They are designed to be practical, informative, and fun.

Background information is provided on the history, theory, and common applications of laser light. There is an introduction to optics, and details on helium-neon lasers—including how to build a complete He-Ne laser experimenter's system. The book offers practical advice concerning necessary tools; where to buy lasers and laser power supplies; sources for components, parts, and systems; and using lasers safely.

The projects show how to use lasers for holography, laser-beam intrusion and de-

tection systems, coherent-light seismology, precision measurements, laser and fiber-optics computer-data links, laser-beam communication, laser guns, and light shows. Several laser power supplies are also included. All projects have been tried and

LASER COOKBOOK



field tested. Whenever possible, the components were designed as separate "building blocks," and readers are encouraged to mix-and-match them for custom designs. Alternative approaches, parts lists, and sources of both electrical and mechanical components are provided.

The Laser Cookbook: 88 Practical Projects is available for \$17.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

PC POWER PROTECTION

by Mark Waller

If you've ever had your computer "crash" due to a power disturbance, you know just how important a reliable power source is. Besides the loss of data, a power surge can cause extensive damage to expensive computer hardware. As we become more dependent on our computers both at home and at work, and as we link our computers to mainframes, minis, other PC's, and fax machines, the problem of "dirty" power grows proportionately. In response to that problem, an array of PC power products have hit the market—but there are few reliable sources of information on what, precisely, those products do, or how well they do it.

This book provides an overview of PC power protection, supplying readers with the information they need to make decisions about protecting their own computers from such power problems as sags, surges, brownouts, and lightning. In non-technical terms, it explains basic electricity; power quality; the dangers of lightning, static, and noise; and proper grounding. The technological approaches to solving power problems are analyzed, and various products are examined in terms of how they work, their strengths and weaknesses, and their applications. The book covers tran-

sient suppression devices, surge suppressors, voltage regulators, the simple power conditioner, standby power systems, and uninterruptible power supply (UPS) designs.

A chapter on the specific problems encountered by local area networks and desktop-publishing systems is included. The book is extensively illustrated, and includes a glossary of all technical terms used.

PC Power Protection is available for \$19.95 from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

TEK 2200 SERIES AFFORDABLE PORTABLES:

How to Choose an Oscilloscope

This 12-page brochure from Tektronix is written for anyone who is considering the purchase of a portable oscilloscope. The array of oscilloscopes and features available today can lead to confusion. The guide covers how to choose between analog and digital scopes, which basic features are essential, and gives clear explanations of advanced automated features.

To help clarify the decision-making process, the section on scope basics includes how to select the appropriate bandwidth, number of vertical channels, vertical sensitivity, triggering features, and sweep speeds. Digital terminology—such as sample rate, resolution, and record length—is



defined. The brochure also describes the capabilities that are unique to digital oscilloscopes, including pre-trigger and waveform storage and transfer. Such automated features as automatic setup and store/recall of front-panel setups are also explained.

TEK 2200 Series Affordable Portables: How to Choose an Oscilloscope is avail-

able at no charge from Tektronix, P.O. Box 1700, Beaverton, OR 97075; Tel. 1-800-426-2200.

CIRCLE 82 ON FREE INFORMATION CARD

GENERAL RADIOTELEPHONE OPERATOR'S LICENSE STUDY GUIDE: Second Edition

by Thomas LeBlanc, NX7P

The FCC General Radiotelephone Operator's License exam was revised so extensively in 1986—one license exam now encompasses the material once covered by three licenses classes, and transistor and digital theory replaces out-dated tube theory—that older study guides were rendered obsolete. Written by a test-prep instructor, this book is intended to help readers to pass the "new" test, and covers all the latest developments in the field. Taking an instructional approach, the book stresses understanding concepts, rather than the rote memorization of answers.

The book includes discussions of harmonics, image reception, calculations of decibels and square-wave components, and various aspects of tank circuits. The new marine and aviation rules and regulations are explained, and FCC rules and regulations

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CIRCLE 12 ON FREE INFORMATION CARD

Electronics Library

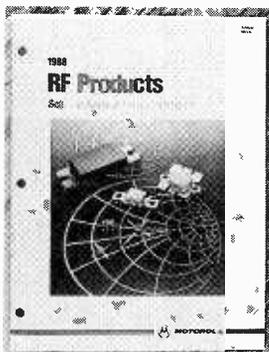
are covered in detail. Also examined are radar fundamentals, series and parallel time-constant problems, troubleshooting three-transistor transmitters, and transistor-bias considerations. Study questions are provided after each chapter; an answer key appears at the back of the book. The author has included a listing of FCC offices that supply information and applications, and a glossary of terms.

General Radiotelephone Operator's License Study Guide: Second Edition is available for \$15.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

RF PRODUCTS SELECTOR GUIDE & CROSS REFERENCE

Motorola's selector guide (SG46/D) has undergone some major changes from previous editions. For the first time, the RF products of Motorola, Phoenix, are combined with those of two additional, new product centers (the result of the acquisition of TRW RF Devices Division in March 1988). A broad line of RF products is represented, including new products for avionics, military, land-mobile/cellular radio, CATV, TV/base stations, and small-signal applications. Several new categories have been added to



to accommodate products that were not previously available from Motorola, including VHF/UHF ultra-linear transistors for TV applications, amplifier modules, and a greatly expanded line of microwave devices.

The brochure is divided into two major parts—discrete devices and amplifiers. Within those parts, there are separate listings for such categories as power FETs, power bipolar AND small-signal bipolar transistors. Parts are listed by frequency band (except for small-signal transistors, which are divided by application). Within a frequency band, transistors are further grouped by operating voltage and output power.

For quick reference, an index and ex-

tensive cross-reference are provided. There is also a section containing package outlines.

The RF Products Selector Guide & Cross Reference is available at no charge, by requesting SG46/D from Motorola Inc., Literature Distribution Center, P.O. Box 20924, Phoenix, AZ 85063; (602) 994-6561.

CIRCLE 83 ON FREE INFORMATION CARD

WINTER 1989 HEATHKIT CATALOG

More than 10% of the new Heathkit catalog is devoted to amateur radio. For newcomers to the hobby, there is a thorough explanation of what amateur radio is, how to get started, how to get QSL cards, and even how to become a member of the American Radio Relay League (ARRL).

Fourteen pages are devoted to Heath's complete line of amateur-radio equipment, both fully assembled and in kit form, including packet radio TNC's, multi-mode SSB/CW/RTTY active audio filters, CW code oscillators, QRP meters, active antennas, noise bridges, and VLF converters. Some innovative products are highlighted, including the SB-1400 100-watt HF all-mode transceiver, which features 20 memory channels and covers all 9 HF amateur bands while offering general coverage reception from 100 kHz to 30 MHz.

Besides amateur-radio gear, the catalog features audio, TV/video, and computer products; radio control devices; marine, weather, security, and public address equipment; educational and starter kits; and tools and test instruments. All kits are rated with the skill level required for assembly.

The Winter 1989 Heathkit Catalog is available upon request from Heath Company, Benton Harbor, MI 49022; 1-800-44-HEATH.

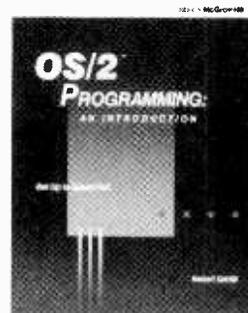
CIRCLE 84 ON FREE INFORMATION CARD

OS/2 PROGRAMMING: AN INTRODUCTION

by Herbert Schildt

Subtitled "Get Up To Speed Fast," this book is designed to save time for programmers, by offering an alternative to poring through endless OS/2 documentation. Developed jointly by Microsoft and IBM, it presents a well-organized, solid foundation in OS/2 programming.

Examples of C programs are used to explain such concepts as multitasking, interprocess communications, and the creation of dynamic-link libraries. Special emphasis is placed on device monitors; file and printer I/O; and screen, mouse, and keyboard services. The book also provides an introduction to the "Presentation Man-



ager" graphic interface, and sample programs from which readers can begin to develop their own OS/2 programs. Useful appendixes include a look at 80286's six memory models, function prototypes, and a review of C.

OS/2 Programming: An Introduction is available for \$21.95 from Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710.

CIRCLE 96 ON FREE INFORMATION CARD

ENCYCLOPEDIA OF ELECTRONIC CIRCUITS Volume 2

by Rudolf F. Graf

This sourcebook includes more than 700 electronic and integrated circuit ideas, for all levels of electronics enthusiasts. A companion book to *Encyclopedia of Electronic Circuits: Volume 1* (published in 1985), *Volume 2* contains all new circuits; none previously appeared in the first volume.

The book's 700-plus pages are packed with circuits, arranged alphabetically from "Alarm and Security Circuits" to "Touch-Switch Circuits." In between, readers will find temperature sensors; timers; probes; radar detectors; games; oscillators; counters; receivers; power amplifiers; battery monitors; converters; and computer, circuit-protection, stereo-balance, tape-recorder, motor-control, function-generator, telephone-

(Continued on page 12)



"Shh, Bob, not in front of you-know-who!"

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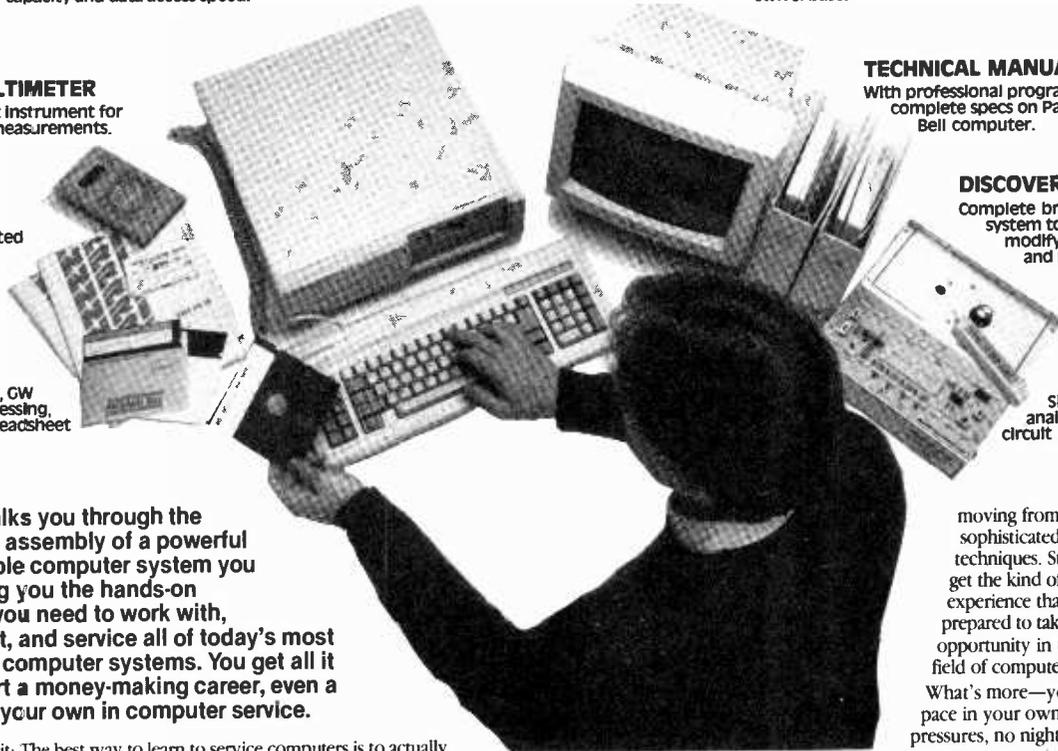
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No doubt about it: The best way to learn to service computers is to actually *build* a state-of-the-art computer from the keyboard on up. As you put the machine together, performing key tests and demonstrations at each stage of assembly, you see for yourself how each part of it works, what can go wrong, and how you can fix it.

Only NRI—the leader in career-building, at-home electronics training for 75 years—gives you such practical, real-world computer servicing experience. Indeed, no other training—in school, on the job, *anywhere*—shows you how to troubleshoot and service computers like NRI.

You get in-demand computer servicing skills as you train with your own XT-compatible system—now with 20 meg hard drive

With NRI's exclusive hands-on training, you actually build and keep the powerful new Packard Bell VX88 PC/XT compatible computer, complete with 512K RAM and 20 meg hard disk drive.

You start by assembling and testing the "intelligent" keyboard, move on to test the circuitry on the main logic board, install the power supply and 5 1/4" disk drive, then interface your high-resolution monitor. But that's not all.

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Your NRI hands-on training continues as you install the powerful 20 megabyte hard disk drive—today's most wanted computer peripheral—included in your course to dramatically increase your computer's storage capacity while giving you lightning-quick data access.

Having fully assembled your Packard Bell VX88, you take it through a complete series of diagnostic tests, mastering professional computer servicing techniques as you take command of the full power of the VX88's high-speed V40 microprocessor.

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Electronics Library

(Continued from page 8)

related, and sound-effect circuits—to name just a few.

In addition, the book includes a comprehensive index, a source index, and a cross-reference to *Volume 1*. A listing of the original circuit sources includes Motorola, National Semiconductor, the National Aeronautics and Space Administration, and Texas Instruments.

The Encyclopedia of Electronic Circuits: Volume 2 is available for \$24.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

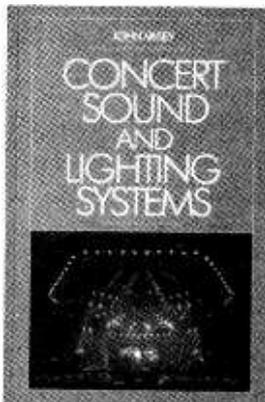
CIRCLE 98 ON FREE INFORMATION CARD

CONCERT SOUND AND LIGHTING SYSTEMS

by John Vasey

This "roadie's handbook" provides comprehensive coverage of the sophisticated equipment and complex setup procedure required for touring concert systems. It is intended as a reference source for those already working in the sound and lighting fields, and as a supplement to practical training for those who plan to enter the field. It offers detailed explanations of how the equipment works, laying the basic foundation for the artistic and creative side of the job.

Before presenting separate sections on sound and lighting, the author delves into power and rigging, which are common to both and are crucial elements of all concert



tours. Introductions to various elements of the touring concert—the touring party, the local crew, and other local personnel—are provided, along with a look at career paths in the field. No prior knowledge is assumed, and the book fully explains how all the various parts fit together to create a safe, efficient show, as well as how the separate components actually work.

The two major sections—sound and lighting—contain detailed explanations of every piece of equipment used, and both sections end with a discussion of the complete

setup procedure for a typical show. The text is accompanied by both photographs and illustrations. Appendixes cover electrical formulas and wiring information, and depict sample production checklists.

Concert Sound and Lighting Systems is available in hardcover for \$24.95 from Focal Press, 80 Montvale Avenue, Stoneham, MA 02180.

CIRCLE 85 ON FREE INFORMATION CARD

COMMUNICATIONS SOURCE BOOK

edited by Sybil B. Parker

This book, part of McGraw-Hill's "Science Reference Series," comprises a collection of articles concerning communications. Each piece deals with one specific area of communications, and is written by an expert in that field. Together, the 120 articles present a comprehensive, in-depth look at radio communications and telecommunications and associated technologies—in one easy-to-use volume.

The articles are arranged by subject, for quick reference, and each subject area contains detailed coverage of particular topics. For example, the chapter on signal transmission includes articles on communication cables, electromagnetic wave transmission, attenuation, microwave transmission lines, optical communications and fiber optics, radio-wave propagation, various antennas, and communications satellites. Other chapters focus on networks and switching, multiplexing and modulation, telegraphy and telephony, radio systems and transmission, television broadcasting, radio and television reception, and specialized communications systems.

Communications Source Book is available in hardcover for \$45.00 from McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011; Tel. 1-800-2-MCGRAW.

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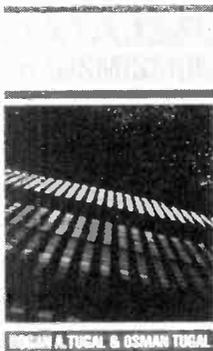


"I'm not going to warn you again, John; watch where you're pointing that stupid laser!"

**DATA TRANSMISSION:
Second Edition**

by Dogan A. Tugal
and Osman Tugal

Although it is aimed at engineers, managers, and technically oriented individuals in the telecommunications field, and examines the theory and concepts of analog and digital data transmission, this book uses only basic mathematical concepts and focuses on real-life applications rather than complex theoretical details. The book includes up-to-date information on every-



thing—from basic principles to advanced design techniques—concerning data-transmission characteristics, systems, applications, and other topics.

To help resolve technical problems that arise during the design stage of a communications system, the book offers time-saving shortcuts and technical tricks for designing or troubleshooting systems hardware. It examines such varied aspects as synchronization techniques, voice-compression methods, packet switching, and packetized voice transmissions. Voice-grade, wideband, digital, radio, cable, satellite, and fiber-optic systems are also covered in great detail.

The second edition has been updated to include such topics as circuit bridging, static electricity, circuit-isolation techniques, and power-supply problems. The book also features a new chapter on local area networks (LANs), and includes coverage of the international standards recommended by CCITT.

Data Transmission (Second Edition) is available in hardcover for \$40.00 from McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011; Tel. 1-800-2-MCGRAW.

CIRCLE 96 ON FREE INFORMATION CARD

**HOME ELECTRICAL WIRING MADE EASY:
Common Repairs and Projects**

by Robert Wood

Written for people with no more electrical expertise than changing light bulbs, this book presents safe and easy procedures for common household electrical jobs. Safety is emphasized throughout the book, which opens with chapters on basic electrical concepts, electrical safety, and legal and zoning considerations.

The actual projects are detailed with step-by-step instructions that are enhanced by plenty of drawings and photographs. Installation projects include outlets, thermostats, garage-door openers, telephone jacks, door bells, timers, outdoor lighting, dimmer switches, and ceiling lights and fans. Troubleshooting techniques for repair and replacement tasks are explained and illustrated. The language is kept as non-technical as possible.

Home Electrical Wiring Made Easy: Common Repairs and Projects is available for \$16.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

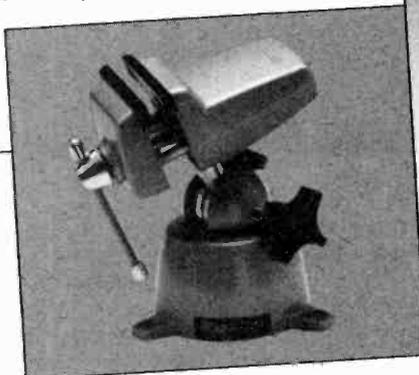
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HOLD IT ANYWHERE YOU WANT IT!

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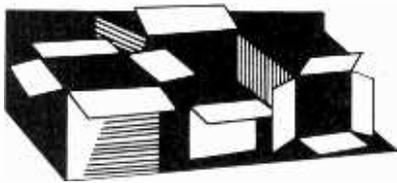


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New Products

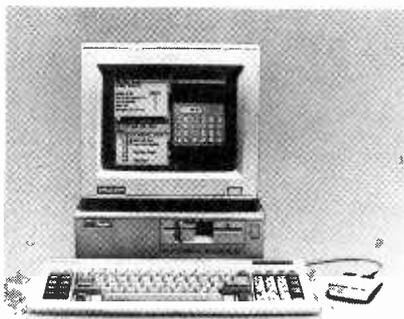
To obtain additional information on new products covered in this section from the manufacturer, please circle the item's code number on the Free Information Card

AT-COMPATIBLE COMPUTER

The *Blue Chip 286* is an AT-compatible computer with an 80286 processor that runs at 10-MHz with one wait state—noticeably faster than that of the original AT.

Several other time-saving features add to that speed. Memory-caching software provides added speed during disk transfers, a common computer bottleneck. To speed applications that make extensive use of calculations, a socket is provided for an 80287 math co-processor. The BIOS portion of the MS-DOS operating system is in ROM for quicker access. To lessen the amount of time needed to learn to run the system, the computer comes with *Mastering MS-DOS 4.01*, a thorough and readable guide-book.

In terms of power, a 40-meg hard disk with AT controller and a 1.2-meg, 5¹/₄-inch



floppy-disk drive occupy two of the three half-height drive slots; one slot is left for additional mass storage, or for other disk formats. The floppy-disk controller (on the system board) supports 5¹/₄-inch drives in 360K and 1.2-meg configurations, and 3¹/₂-inch drives in 720K and 1.44-meg formats. A software-setup utility guides the user in setting up system parameters for any combination of drives and formats.

The 512K memory is expandable to a full megabyte on board; that leaves six of the eight slots available for future expansion. The power supply has a full 200 watts of capacity to handle future additions.

The *Blue Chip 286* system includes a 101-key AT-style keyboard and EGA, CGA, or VGA color-video graphics output. Two serial RS-232 communications ports and one parallel-printer port are included, and a clock/calendar is built onto the system board.

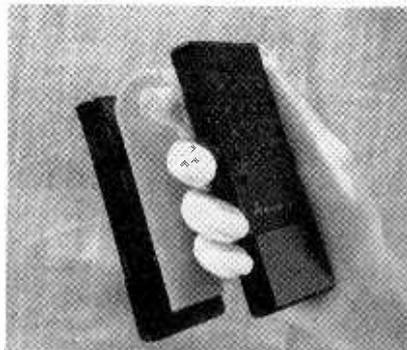
Prices for the *Blue Chip 286* AT-compatible computer system start at \$1,299.00. For additional information, contact *Blue Chip International, Inc.*, 7305 West Boston St., Chandler, AZ 85226.

CIRCLE 70 ON FREE INFORMATION CARD

DUAL REMOTE-CONTROL HOLDER

As audio/visual systems get more elaborate, we have an increasing assortment of peripheral gadgets to deal with—including more than one remote-control unit. It's easy enough to misplace one; with each additional unit your chances of quickly locating the right one at the right time decrease.

Clicker Products has introduced a simple device to give you more control over your remote controls. Their patent-pending *Clicker Holder* keeps two remotes in one place. The *Clicker Holder* is a flat piece of plastic that is bent to resemble a "U". It comes with strips of Velcro that are used



to secure two separate remote-control units, one on each side of the holder. The holder's configuration allows easy access to both remote controls—you can grip it through the middle as though you were holding a single remote control. Having two of them attached makes both units more obvious, and less likely to slip between the cushions of your sofa or get lost under the TV guide.

The *Clicker Holder* has a suggested price of \$5.95 in single quantities, including shipping. For more information, contact *Clicker Products*, 953 Hurlstone Ln., San Jose, CA 95120.

CIRCLE 75 ON FREE INFORMATION CARD

VIDEO LIGHT

Thomson Consumer Electronics' RCA Model VDC050 is a 35-watt DC video light

that is designed for use with all makes and formats of camcorders. The 12-ounce light features a heat-resistant housing, making it both safer and more efficient.

Its unique reflective lamp has a dichroic coating that reflects 85% of the heat-producing infrared waves back and through special louvers located on the sides of the lamp. To reduce the heat level further, the



light has a double, thermal plate-glass lens at the front surface.

By incorporating an efficient quartz-halogen, multi-mirror lamp, Thomson was able to reduce wattage to 35 watts. Thus, the *RCA VDC050* consumes less battery power, yet provides adequate light levels for indoor shooting.

The *RCA VDC050* has a suggested retail price of \$99.95. For additional information, contact local *RCA Video Accessories* distributors, or *RCA Sales Promotion Services*, Deptford, NJ 08096.

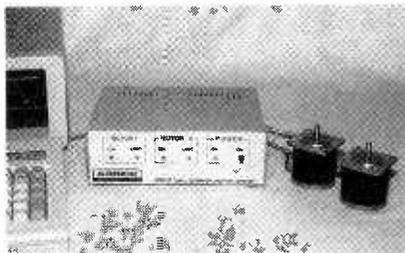
CIRCLE 76 ON FREE INFORMATION CARD

DUAL STEPPER-MOTOR DRIVER PACKAGE

Arrick Robotics' MD-2 dual stepper-motor driver package includes everything needed to operate stepper motors from an IBM PC, XT, AT, PS/2, or compatible computer. (Parallel printer port and cable, 256K, and DOS 2.1 or greater are required.) Typical applications include robotics, telescope positioning, X-Y tables, conveyor belts, and industrial automation machines.

The package allows sophisticated motion control on a limited budget. The *MD-2* contains a motor driver with 6-foot AC power cable; two size 23 stepper motors with 6-foot cables; two mechanical, lever-type limit switches; and a power supply. It also includes software utility programs that allow control of up to six motors on one computer, using a keyboard or joysticks. Sub-routines are written in several languages for custom applications. Extensive technical documentation provides all the information needed to use the package effectively.

The *MD-2* is easy to use by simply connecting the driver to the parallel printer port,



plugging in the motors, and running the software. Front-panel lights display the status of each motor and the limit switches.

The MD-2 dual stepper-motor driver package, including two free software updates, costs \$399.00. For further information, contact Arrick Robotics, P.O. Box 1574, Hurst, TX 76053.

CIRCLE 77 ON FREE INFORMATION CARD

CLAMP-ON DIGITAL MULTIMETER

Triplet's Model 44 is a digital, clamp-on multimeter with a 3 1/2-digit LCD display that has a maximum reading of 1999. It is compact sized to be easily hand held, and has a jaw-opening capability of 50mm.

The unit features peak hold, data hold, diode check, and continuity. It offers 3 AC-current ranges (from 20 to 1000 amps), 2 AC-voltage ranges (from 200 to 750 volts), and 2 DC-voltage ranges (from 200 to 1000



volts). Other standard features include indicators for over input ("1" or "±1"); for low battery; and for automatic negative polarity. The Model 44 runs on a single 9-volt battery, with an expected battery life of 200 hours.

The Model 44 digital clamp-on multimeter, complete with a pair of test leads, battery, carrying case, instruction manual, and

a one-year warranty, has a suggested retail price of \$97.50. For additional information, contact Triplet Corporation, One Triplet Drive, Blufton, OH 45817.

CIRCLE 78 ON FREE INFORMATION CARD

SPELL CHECKER

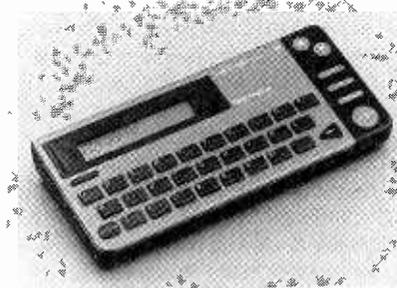
The Ready Reference Spell-Checker from Texas Instruments is an advanced hand-held, electronic spelling checker that offers a data base of more than 93,000 words and several features that make it faster and easier to use than a standard dictionary.

The Ready Reference features a special ENDINGS key that can display a root word with its most common endings, making it easy to determine the proper plural form of a word. For crossword-puzzle buffs, the WILDCARD key can be used to represent a single missing letter, and the MISSING SERIES to represent a group of missing letters. Users can even find correct spellings by entering words the way they sound. Phonetically based software will retrieve the proper spelling of such entries as "nabor" (neighbor).

The spell checker's keypad is set up like a typewriter's. Control keys are grouped for convenience, and users can scroll

quickly through word lists with the up- and down-arrow keys. An easily readable dot-matrix display shows 15 characters and has adjustable contrast. Messages and status indicators are displayed so that users can keep track of the function being performed.

Designed to be carried from home to school or office, the Ready Reference meas-



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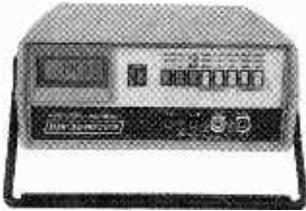
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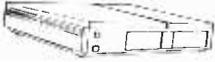
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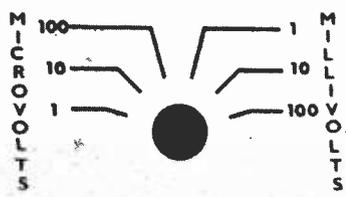
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ter (compared to the average camcorder's 1/60-second shutter speed) allows the user to freeze fast-moving objects without sacrificing clarity. Action shots feature finely detailed movements and no blurring. A 6x power-zoom lens can be switched back and forth between wide-angle and telephoto modes, for more creative recording. In its macro mode, the lens can focus on objects as close as 1 cm.

For special effects and animation on time-



lapse recording, the camcorder features 4 interval recording modes—30 seconds and 1, 2, and 5 minutes. When the stand-by time is used to set up a shot, the camera will automatically record for 1 second and then return to stand-by while the next shot is set up. Manual frame recording (4 frames at a time) is also possible.

Other features of the 8AF KD-3030 include hi-fi sound and a "wind switch" that is built into the microphone for low-frequency (such as the sound of the wind) noise reduction. The unit's electronic viewfinder is designed to swivel up to 110° for optimum angle shots. It features an "info center" that displays shutter speed, tape remaining, tape counter, battery condition, record-light indicator, and proper date (when date-recording feature is active).

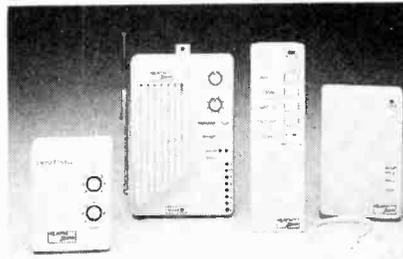
The Finemovie 8AF KD-3030 camcorder has a suggested list price of \$1,830.00. For additional information, contact Yashica Inc., 100 Randolph Road, CN 6802, Somerset, NJ 08873.

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HOME-SECURITY SYSTEM

Heath Zenith's SS-6100 is an economical, fully expandable, wireless home-security system. The Supervised Home Protection System is designed for simple installation by the user. It includes a control center, a door/window sensor, a lamp module, and a remote arming and disarming control.

The system is self-testing; it checks itself regularly to verify that all door/window and motion sensors are working. Battery back-up ensures that the system stays operational even in the event of a power failure. It automatically learns its own unique security codes, so that the user doesn't have to program it.



The control center features a loud alarm, and has LED's that identify in which zone

the potential break-in is occurring. The door/window sensors are easy to place at any point of entrance. A plug-in module provides remote control of lights; when an intrusion takes place, lights flash as the alarm sounds.

The SS-6100 system is expandable to 16 zones of coverage. For custom applications, a full line of accessories is available—including extra door/window sensors, command units, and lamp modules; a remote siren/dialer connection; an auto (Continued on page 22)

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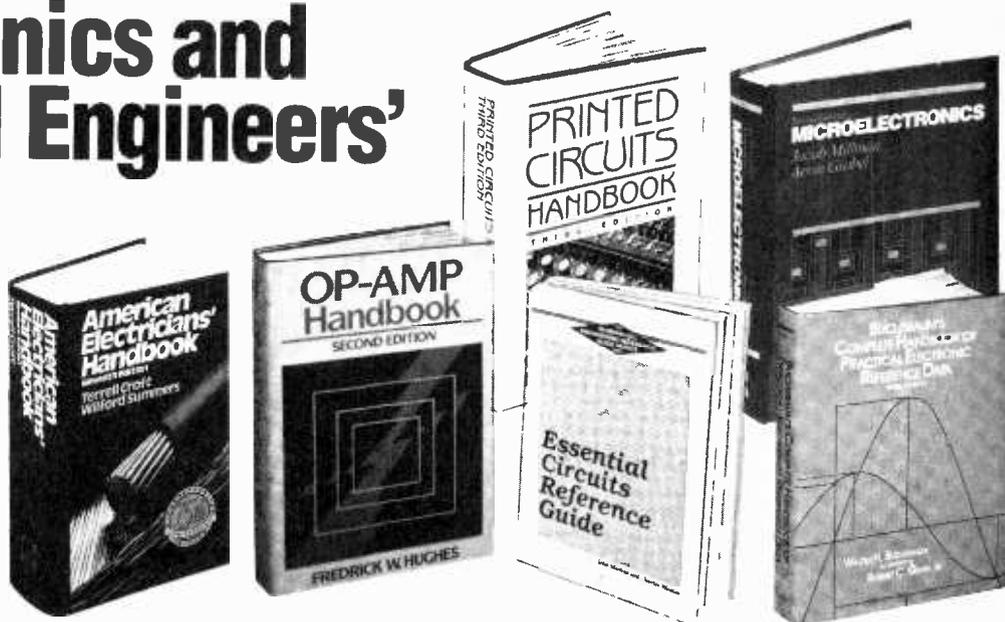
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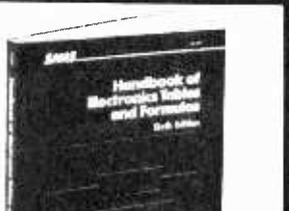
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New Products

(Continued from page 17)

dialer; motion sensors; and a remote dimmer/controller.

The SS-6100 Supervised Home Protection System has a suggested retail price of \$99.95. For additional information, contact Heath Zenith Consumer Products Group, Hilltop Road, St. Joseph, MI 49085.

CIRCLE 74 ON FREE INFORMATION CARD

TELEPHONE ANSWERING SYSTEMS

Code-A-Phone's Models 1610 and 1620 telephone answering systems are targeted to residential consumers who are looking for durability, affordability, and ease of operation. Both systems offer contemporary styling and several convenience features.

The one-touch message-playback feature plays messages and resets the unit to receive new messages, all at the push of a single button. The systems can be remotely activated from any tone phone. "Power fail protection" preserves both the



outgoing announcement and recorded incoming messages from power surges as well as power outages. Call-screening allows the user to listen to a caller before picking up the phone, to avoid unwanted calls.

Model 1620 (pictured) also offers 6 remote commands, including message repeat and message save or cancel. A personal security code is used to access all remote functions.

The Model 1610 and 1620 cost \$69.95 and \$79.95, respectively. For more information, contact Code-A-Phone Corporation, 16261 S.E. 130th, Clackamas, OR 97015.

CIRCLE 66 ON FREE INFORMATION CARD

RADIATION MONITOR

There's been a lot of talk lately about the dangers that radon gas, and other forms of radiation, present to peoples' health. With International Medcom's Radalert, you can easily test radiation levels, monitor changes in those levels, detect radiation leaks, de-

termine patterns, and screen for radon gas in your home. The unit is available fully assembled, or in kit form for experienced kit builders.

The Radalert is a hand-held unit that detects Alpha, Beta, Gamma, and X-rays. Its digital LCD display can show counts-per-minute or accumulated counts, and the audio alarm features an adjustable alert



level. The unit can be interfaced to a computer for recording monitored levels, or to an external warning device. The Geiger-tube radiation detector is sensitive enough to measure radiation from uranium-oxide pottery glazes, old radium-dial clocks and watches, gas camping-lantern mantles, and rock collections. The Radalert is powered by a 9-volt battery; a jack is provided for an optional AC adapter.

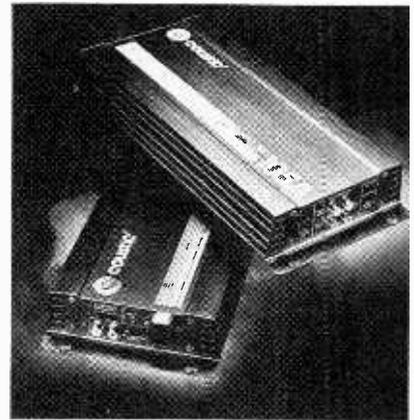
The Radalert, fully assembled, costs \$275.00; in kit form, it costs \$185.00. (There is also a shipping charge of \$4.00.) For further information, contact International Medcom, 7497 Kennedy Road, Sebastopol, CA 95472; MasterCard and Visa orders only, call 800-257-3825 (800-255-3825 in CA).

CIRCLE 69 ON FREE INFORMATION CARD

CAR AMPLIFIER

Coustic's AMP-105A is an entry-level, 4-channel automotive amplifier that is designed to provide a low-cost upgrade for standard car-audio equipment.

The AMP-105A can drive both front and rear speakers at up to 45-watts per channel. It drives as little as 2-ohms, or as many as eight 4-ohm speakers. The amplifier has an independent subwoofer output that offers selectable 12-dB-per-octave low-pass electronic crossover capabilities for additional bass, eliminating the need for a separate electronic crossover. To ensure excellent high- and low-frequency responses, the AMP-105A uses BTL-type output circuitry.



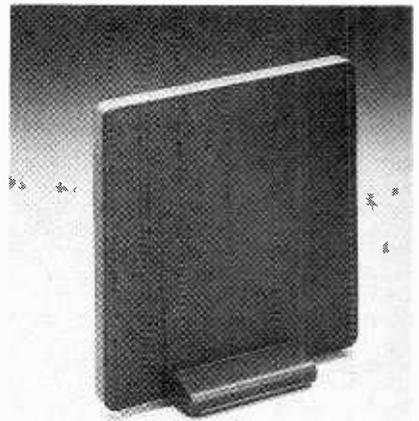
Other features include high/low-impedance input, a parallel-input switch, adjustable input sensitivity for overall system gain, and floating/common-ground input isolation.

The AMP-105A 4-channel, automotive-audio power amplifier has a suggested list price of \$179.95. For additional information, contact Coustic, 4260 Charter St., Vernon, CA 90058-2596.

CIRCLE 68 ON FREE INFORMATION CARD

OMNIDIRECTIONAL FM ANTENNA

Terk Technologies' FM+ is a nearly flat, square-shaped omnidirectional antenna. Using "Gamma Loop" technology, the FM+ makes clear FM sound easily affordable, in a uniquely styled antenna. A smooth, thin, 5-inch black square that fits neatly into virtually any shelf space, its industrial/



geometric design and sleek dimensions give it a high-tech look.

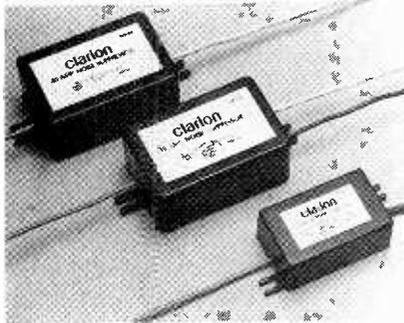
The FM+ omnidirectional antenna costs \$19.95. For further information, contact Terk Technologies Corporation, 56 Harrison St., New Rochelle, NY 10801.

CIRCLE 67 ON FREE INFORMATION CARD

NOISE SUPPRESSORS

Clarion's noise suppressors, part of their new line of car-stereo accessories, were

developed to eliminate alternator noise. Three models are offered; each is designed for a different current rating. The NS-7, with 8-amps capability, is intended for use with Clarion head units. The 15-amp NS-15 is designed for Clarion's EQ and BTL ampli-



ers, and the NS-40, with 40-amp capability, is for use with high-powered amplifiers.

The NS-7, NS-15, and NS-40 noise suppressors cost \$10.95, \$13.95, and \$23.95, respectively. For more information, contact Clarion Corporation of America, Sales Department, 5500 Rosecrans, Lawndale, CA 90260.

CIRCLE 80 ON FREE INFORMATION CARD

PHONE/FAX COMBO

Canon's FaxPhone 15 combines sophisticated telephone and facsimile-machine (Fax) features in one compact, lightweight unit. Designed for both corporate- and home-office use, its convenience features include one-touch speed dialing to as many as 12 locations, last-number redialing, on-hook dialing, hold, and a monitor speaker with volume control.

The sleek, black FaxPhone 15 weighs only 8.4 pounds and measures 12¹/₁₆ × 10⁷/₈ × 4¹¹/₁₆ inches. Easily transportable,



it is hooked up by simply plugging it into a standard modular phone jack and an electrical wall outlet. An optional carrying case is available.

The unit is G3 compatible, and can send a letter in only 30 seconds at 9,600 bps. Transmission is facilitated by the FaxPhone 15's automatic 5-page document feeder, fine mode, and automatic background control and reception. After each transmission, the unit automatically generates an activity

report, giving users a complete record of fax transactions.

The FaxPhone 15 has a suggested retail price of \$1,695.00; the carrying case costs \$70.00. For more information, contact Canon U.S.A., Inc., One Canon Plaza, Lake Success, NY 11042.

CIRCLE 64 ON FREE INFORMATION CARD

DIGITAL STORAGE OSCILLOSCOPE

The Philips PM 3308 from John Fluke Mfg. Co. is a 100-MHz digital storage oscilloscope with an electroluminescent (EL) screen. With its "clam-shell" design (the screen flips up to open and snaps down to close) and a shoulder strap, the 14.5-pound scope is designed for field-service and -maintenance work. The unit features a powerful mass-storage memory and an array of arithmetic and analysis facilities, making it possible to make laboratory power-



measurements and analyses out in the field.

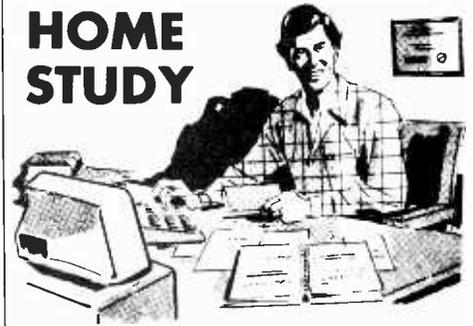
The PM 3308's battery-backed, 180K RAMdisk's non-volatile memory can store up to 100 waveforms and/or setup menus. That reduces the risk of losing field-service data by eliminating the need for external, often vulnerable, mass-storage devices. Because of the scope's versatile measurement and calculation functions, it can replace a conventional scope, a DMM, and a counter in many service applications.

For ease of operation, the PM 3308 offers "Autoset," which provides instant front-panel setting of any input signal through the frequency range. The unit has two input channels, along with a third extended trigger input. The 100-MHz scope has a maximum 40-MS/s sampling rate on one channel, and an 8-kilobyte acquisition memory. GPIB and RS232 interfaces are standard.

The Philips PM 3308 digital storage oscilloscope has a suggested U.S. list price of \$7,500.00. For further information, contact John Fluke Mfg. Co., Inc., P.O. Box C-9090, Everett, WA 98206; Tel. 800-443-5853, ext. 77. ■

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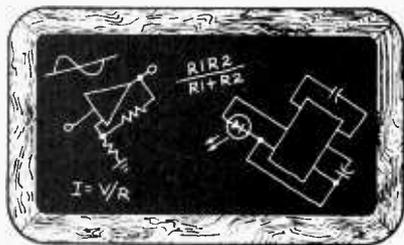
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Think Tank

WHAT DO ELECTRONICS EDITORS TALK ABOUT?

By Byron G. Wels

If you've got the idea that in an electronics publishing office the editors walk around with somber faces saying things like "The frequency at resonance equals one over two pi (π) the square root of LC," you're sadly mistaken. We're only human, so (like yourself) we talk football and baseball (depending on the season), working on articles, manuscripts, layouts, proofreading and such.

In other words, it isn't often we all get involved in deep technical discussions, but it happened yesterday. In retrospect, it all seems kind of silly. The question that arose concerned such a basic function in electronics, something all of us took for granted, but the arguments on both sides seemed perfectly rational. I thought I might share it with you.

If you have six 5% tolerance resistors connected in series, what will the total tolerance be? Will it remain 5%? Will it be 30%? Or will it be some other figure computed by logarithmic functions? After a great deal of discussion, drawing of diagrams, we finally agreed. I'll give you the answer we arrived at, and how we reached it, at the end of this column. But what amused me, was the fact that everybody got into the act, arguing back and forth for almost a day.

This month, we're going to look at some more reader contributions that we felt were worthy of a free copy of the FIPS book. Now understand that all you're going to learn from that book is what a fantastic electronics writer Hugo Gernsback was, and how much it hurts when you laugh so hard you've got to hold your sides!

Out to Launch. By, I got into the model-rocketry hobby several years ago, and have built many solid-fuel, model rockets since. The fuel is ignited by a fuse wire powered by a lantern battery. For safety's sake, I made a simple remote launcher that could be placed close to the launch pad to eliminate long runs of heavy-gauge wire from the battery.

See Fig. 1. The components are all available from Radio Shack, and the retail cost is about \$10.00. Simply place the launcher near the pad and connect the circuit via alligator clips to the fuse. Throwing the toggle switch (S1) causes capacitor C2 (a 300- μ F unit) to charge through the 1-megohm resistor R1.

After about 15 seconds, the charge on C2 is sufficient to trigger SCR1 into conduction, which in turn activates relay K1 (a Radio Shack 275-240 unit). With K1 activated power is applied to

the fuse wire and I1 (a No. 47 incandescent lamp), causing the lamp to come on. I used the lamp instead of an LED because it is more visible in sunlight.

When the relay closes, C1 (a 100- μ F capacitor) charges through R3, a 330K resistor. After a six-second burn, the SCR conducts, transistor Q1 turns on, and the relay drops out. About 15 mA flows through the SCR until the toggle switch is turned off.

You can alter the time constants if you like, but the values given here have provided nearly flawless launches while the "rocket scientists" stood a safe distance away. The circuit was assembled in a plastic box and mounted to the terminals of a heavy-duty lantern battery.

—William E. Lahr, Compton, CA.

Good project Bill! For your next project: How about a radio-controlled launcher that needs no wire connections? Do that up, and you'll have two Fips books.

Bomb Detector. Okay Byron, you wanted simple circuits. Let me explain the following and how it came to be. Quite a few years ago in the city of Berkeley, police cars were being blown up all over the place, and the cops took to checking under the hoods before getting into their cars! I came up with this circuit, but was too shy to offer it to them.

Refer to Fig. 2. While the circuit itself does not detect explosives, it will give some indication of whether your vehicle has been tampered with. Switch S1 is a normally-closed pushbutton type switch, whose contacts are opened when the switch is depressed. Switch S1 is placed under the hood, so that it is depressed by the hood when closed.

When the hood is opened, S1's contacts close applying a gate-trigger voltage to SCR1, causing it to conduct. It continues to conduct, even after the hood is re-closed. With SCR1 conducting, a 14-volt lamp in a pilot-lamp socket comes on and can only be turned off after the reset switch (S2) is pressed. All the driver has to do when coming back to his car, is glance at the lamp. If the lamp is lit, he knows the car has been tampered with. Now how's that for a simple circuit?

—Frank J. Steffanelli, El Cerrito, CA

That's a cute idea, Frank. And it has several other worthwhile applications as well. With no modification, for example, it can be used as a tamper switch elsewhere. How about rigging it

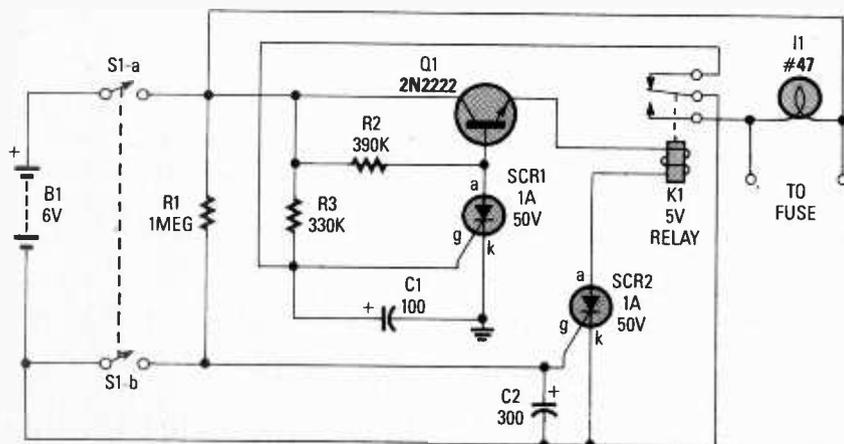


Fig. 1. The rocket launcher is a rather simple circuit, whose operation is almost solely dependant on two SCRs and a relay.

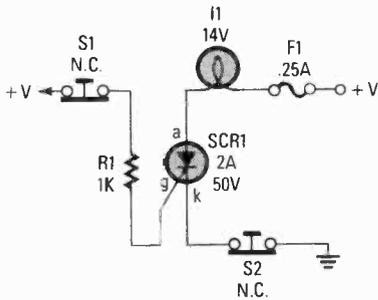


Fig. 2. This circuit uses an SCR, two pushbutton switches, and an incandescent lamp to indicate whether your vehicle has been tampered with.

to a telephone handset so that you can tell if your phone has been used while you were out? Or on a desk drawer? Great idea, and thanks for your contribution. Hope you enjoy the Fips book.

Battery Offer. Our next circuit, a automatic-shutoff switch for battery-powered projects, was sent in by Dave Zabinski. Judging from the schematic diagram, the finished circuit is certainly small enough to fit space in almost any enclosure.

As can be seen in Fig. 3, when S1 (a normally-open, momentary-contact pushbutton switch) is depressed, C1 begins to charge to the supply voltage. That places a forward bias on the gate of Q1 (a VN10KM power MOSFET), turning it on and supplying current to the load resistor (R_L).

When the charge on C1 leaks off, the transistor shuts off, cutting off current to the load. That load could be anything from a transistor radio to a child's toy. Transistor Q1 (available from Radio Shack as part No. 276-2070) is rated at 0.5-amps at 60-volts DC. For heftier

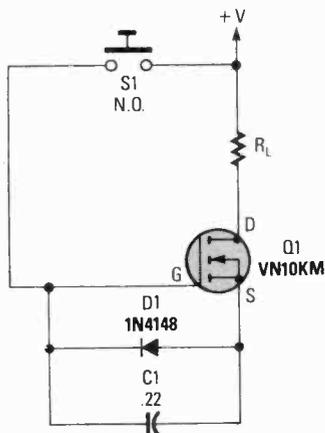


Fig. 3. In this circuit, an FET along with a capacitor is used as an automatic cut-off, electronic switch.

loads, substitute an IRF511 (Radio Shack part No. 276-2072). That would supply up to 3-amps at 60-volts DC.

Surprisingly long delays can be obtained with low capacitance values. With a supply voltage of 9-volts DC and with C1 rated at 0.22 μ F, a delay of about one minute is produced and with C1 rated at 1.0 μ F, you should get about an hour. The normally-open pushbutton switch replaces the on/off switch of the device, and optionally, another normally-open pushbutton switch could be added in parallel as a

shut-off before the timing cycle is completed.

I hope this earns me a copy of the Fips book.

—David R. Zabinski, Apollo, PA

Are you kidding Dave? It sure does! I'd like also to say that if you're dealing with battery-powered projects that use a 9-volt transistor-radio battery, and plan this as a permanent installation, it would be a good idea to remove that first pushbutton switch, and instead wire up a battery connector output that could be snapped in series with

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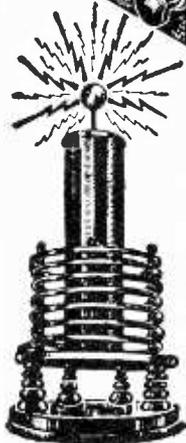
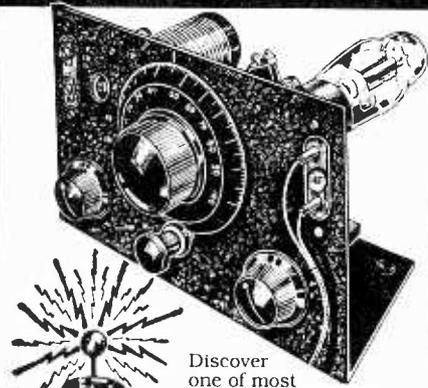
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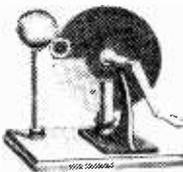
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THINK TANK

the circuit's battery supply line, since most on/off switches connect directly to the supply.

Lights-On Warning. "Hi Byron!" Writes Fred Blechman. "Why make a lights-on warning device that takes oodles of parts and costs a small fortune, when you can accomplish the same feat with a simple \$2.99 part?"

Figure 4 shows a circuit that uses a Radio Shack solid-state buzzer (Radio Shack part No. 273-060), a 4.7-kHz piezo unit. Simply connect the red lead of the buzzer to the light fuse, and the black lead to the radio fuse. That's about it!

When both the lights and ignition or some accessory are on, there is no voltage drop across the buzzer, and therefore no current through it, so the unit remains mute. When the lights are on and the ignition or accessory is off, battery voltage will seek ground through the radio circuit, sounding a warning.

Since the buzzer is a solid-state device and is polarity sensitive, no diode protection is required if the ignition and lights are off, but it's a good idea. The 1N4001 diode shown offers some degree of protection. If you like, you could substitute a 12-volt DC buzzer, but in that case, make sure you use the diode.

—Fred Blechman, Canoga Park, CA

I'd like our readers to know that Fred's name is not unknown to me, nor to many electronics hobbyists. He is a long-time writer and editor in the electronics field, and a good friend to us

all. Thank you for the submission, Fred. Usually, I like to make some comment on a submitted circuit, but yours is so simple and direct that no more need be said!

Two-for-One Sale! Tim Swogger writes: This circuit can be used to charge an auxiliary battery in your camper or trailer as you drive along the road. (See Fig. 5A.) The 9-volt Zener diode passes voltages above nine volts. When the automobile-battery voltage reaches about 13 volts, the relay is energized connecting the car's battery and charging system to the auxiliary battery through the taillight wiring. By the simple expedient of turning on the taillights as you drive, you charge the auxiliary battery system, provided that you don't allow it to discharge too much in the first place. Turning the parking lights off completely disconnects the auxiliary battery from the car's battery.

Then for a bonus, Tim tosses in another quickie: Tired of changing the itty-bitty light bulbs in your front doorbell switch? It seems they go after about a month or two, and I solved the problem handily by using a yellow LED. (See Fig. 5B.) You've also got to add a 100-ohm limiting resistor in series with the LED. It is invisible in daylight, but at night it gives off a soft, warm glow. Just connect it across the terminal screws (with the resistor).

—Tim Swogger, Sharon, PA

Incidentally readers, all of the components are available at your local Radio Shack store.

Another Lights-On Reminder. It seems that these ideas are self-generating! Run one story on a lights-on re-

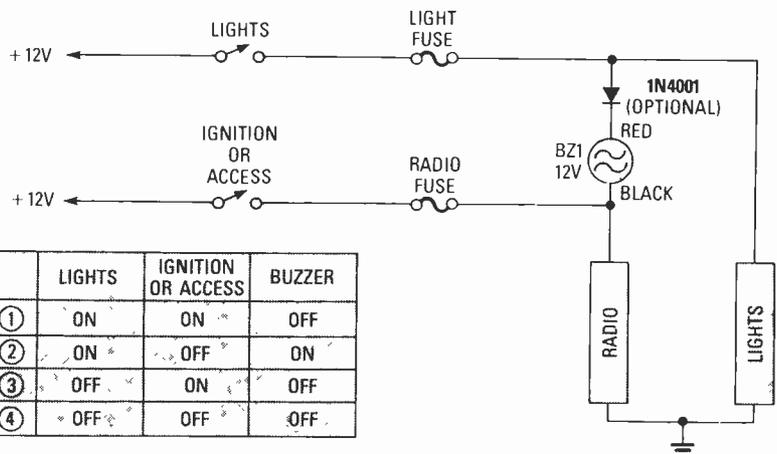


Fig. 4. With the addition of two components, your auto is able to tell you when you've left the car's lights on.

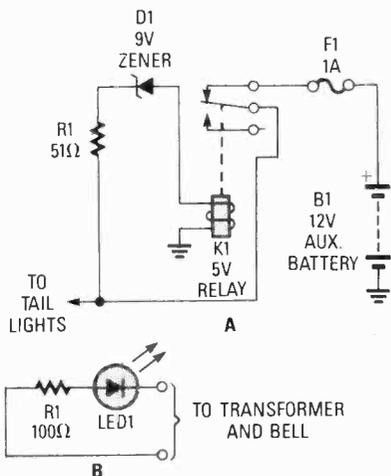


Fig. 5. The circuit in A allows you to charge the main battery in your camper from an auxiliary battery while the vehicle is in motion. The circuit in B can be used to replace a burnt out lamp in your doorbell system.

minder, and you get loaded with 'em! Ron Gooslin, of Chatanooga, offers one that comes in at under two bucks, so it won't break you:

Buy the buzzer (Radio Shack part No. 273-055) for \$1.69. Ignore the mounting holes and when you've got it all wired up, just put a drop of silicone

cement on the underside, and attach it to a clear space on your fuse block in the car.

Here's how to wire it up: Connect the red lead from the buzzer to the light-switch circuit. (See Fig. 6.) The simplest place would be the nearest parking light. Connect the red lead of the buzzer to the ungrounded side (hot side) of the light. Then connect the black lead to the oil pressure switch, which is mounted in the engine. Some cars have an oil gauge and no pressure switch. In that case, connect the black lead from the buzzer to the door switch that operates the dome light. When you open the door, it will remind you that the lights are on.

Here's how it works: When the engine is off, the oil-pressure switch is on, and when the engine is running, that same oil pressure switch is off. That's why the oil pressure light on your dash is out when the engine is running. If you leave your car lights on, power will be applied to the buzzer, causing it to sound. (The switch is on, completing the circuit to ground.) Turning off the light switch cuts off the battery voltage and therefore, the buzzer. When you're driv-

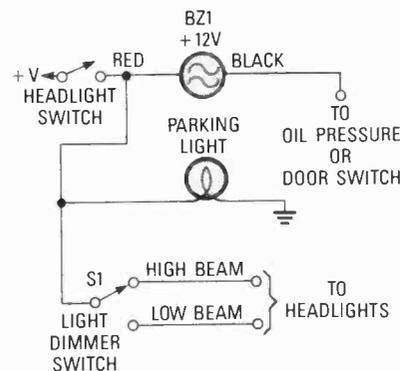


Fig. 6. By properly installing a buzzer in your auto, you'll be alerted whenever you inadvertently leave on the lights.

ing, engine oil pressure opens the switch and the buzzer is disconnected on its negative side. Turning on the headlights while driving will not sound the alarm.

—Ronald Gooslin, Chattanooga, TN

Thanks, Ron. I'd make one small suggestion however: Since the buzzer will operate in any position, why not mount the cover of the buzzer to a clear space on the fuse block? That way, when you decide you want to remove it for any reason, just pull it off the cover,

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FREE CATALOG

THINK TANK

leaving the empty cover right there? Look for a copy of the FIPS book. I sent it out today!

Logic Probe. If you do any amount of logic tracing, this probe will be found almost a necessity. This is especially true if the circuit being traced has a number of integrated circuits. I built the circuit (see Fig. 7) by installing the components on small terminals mounted on an unprocessed piece of printed-circuit material with the copper foil removed except for about half an inch on the probe end.

I soldered the stylus to that. I used a small brass 4/40 screw with the end sharpened as a stylus. A nut secured the board to a plastic tube. The resistors were chosen to provide equal illumination for the lamps in either the high or low state.

To use the probe, first connect the power leads (watching out for the polarity) to the circuit under test. If the circuit is open, neither of the test lamps will light. If the circuit is grounded, the low (or zero) lamp will light. If three to

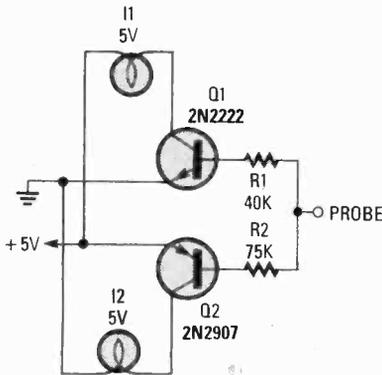
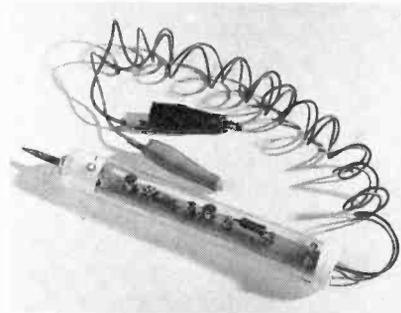


Fig. 7. By connecting this circuit to a logic device that's under power, you can get an indication as to its status.



D. W. Naylor enclosed his logic probe in a clear plastic housing. A small brass screw was used as the probe tip.

six volts is present, the high volt lamp will light.

Other than its application in logic testing, the probe is also convenient for checking supply voltages and grounds. It's much faster than taking assorted meter readings, especially on a well-populated board. You can select resistors to turn the lamps on at any desired threshold voltage within the component limits, making the probe suitable for any logic level. I hope this earns me a FIPS book!

—D. W. Naylor, Osawatomie, KS

Enclosing the whole thing in a plastic vial seems a good idea, Mr. Naylor. And thanks a whole, big bunch. Your FIPS book is on the way.

That about does it for this month. Be sure to send in your schematics with detailed descriptions. There could be a free copy of the Fips book waiting for you! Send them to *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

Oh...By the way, the ultimate answer to our original question is that six five percent tolerance resistors connected in series will *still* have an overall tolerance of five percent! ■

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QRB

*Avoid the dead
battery blues by
installing this circuit
to let you know when
you've left your
auto lights on.*

BY CHARLES R. BALL, JR.

Remember that foggy, rainy morning that you rushed into the office and left your lights on? Remember how long it took the service man to get out to jump start your car? Remember how much that little bit of forgetfulness cost? Well you don't have to worry about that ever again, if you install the simple *Light Warning System* described in this article.

The Light Warning System automatically sounds an alarm if you turn off the vehicle's ignition while the headlights or parking lights are on. The alarm ceases once the lights are turned off. That's peace of mind for under \$15.

Circuit Operation. The circuit shown in Fig. 1 is built around the everpopular 555 oscillator/timer. When the ignition and either the headlights or parking lights are on, little or no voltage dif-

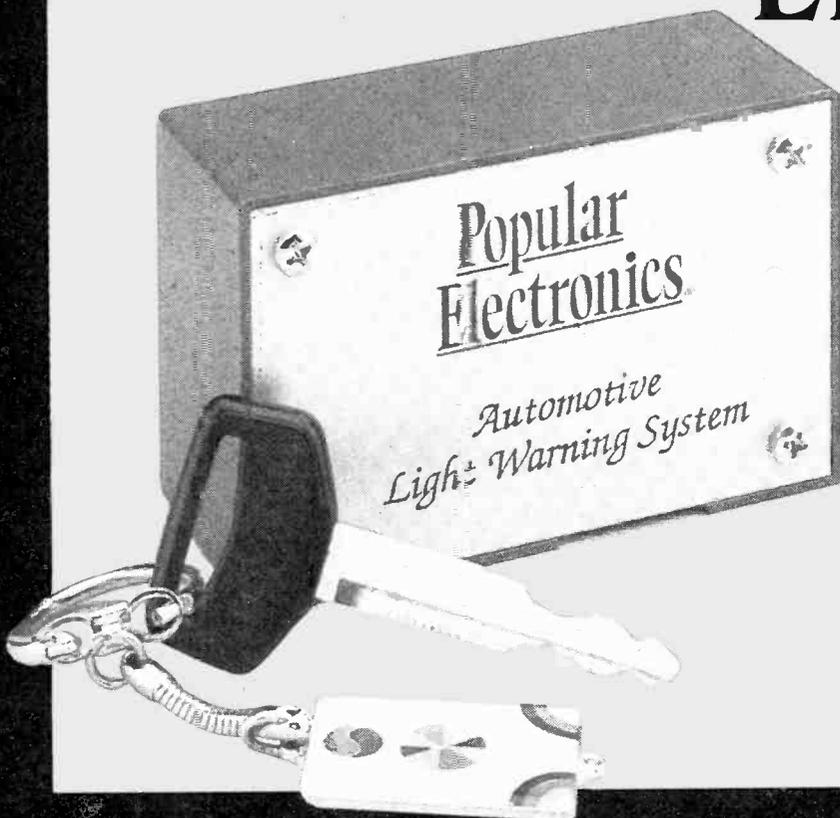
ference exists between the headlight/parking-light circuits and the ignition circuit.

If either the headlight or the parking-light circuit is active and the ignition circuit is off, a voltage difference that is sufficient for alarm operation develops across U_1 . Diodes D1 and D2 are connected in an or-gate arrangement, so that either will pass a positive voltage from its anode to U_1 .

The oscillator starts, and sounds a warning tone via the piezo buzzer. The frequency of the tone may be changed (within limits of piezo response) by varying the values of R1, R2, or C1, or any combination thereof. Potentiometer R3 serves as a volume control to set the sound to a suitable level for the user.

Diode D3 blocks reverse current when the ignition alone is on. Zener diode D4 may be required to provide

BUILD THIS Lights-On Warning System for your Car



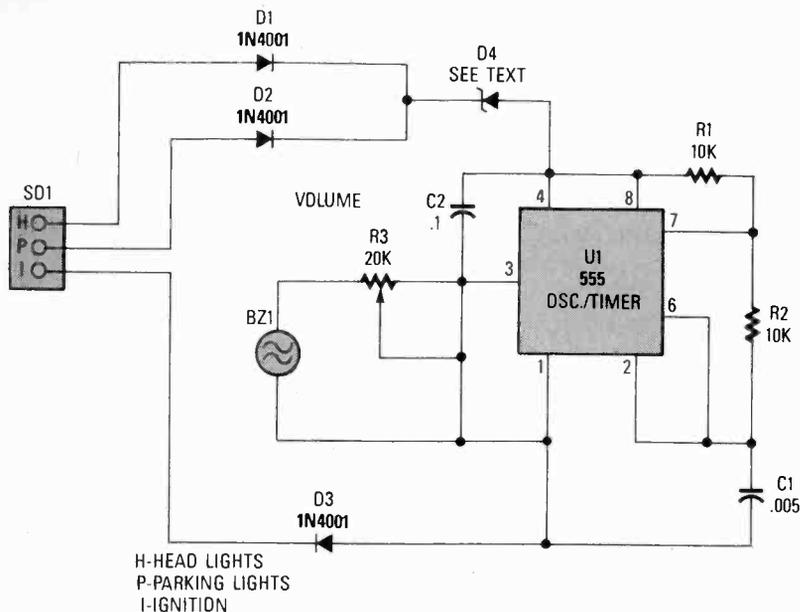


Fig. 1. The automobile Light Warning System is built around the a 555 oscillator/timer, and receives power from the car's battery.

a threshold to prevent false alarm operation if there is a small voltage difference in the DC supply circuit during normal operation. To determine the necessity and/or the value of D4, with the headlights and ignition both on, measure the voltage between the head lights and parking lights (points H and P in Fig. 1).

If you measure more than 1.4 volts, the Zener is required. The Zener's voltage rating should be slightly higher than the difference between the measured voltage and 1.4 volts. For example, if the measured difference is, say, 1.76 volts, the Zener should have a voltage rating of $1.4 + 1.76$ volts or 3.16 volts. The closest off-the-shelf Zener would be a 3.3-volt unit.

For low voltage differences, one or more forward-biased silicon diodes can be substituted for the Zener. Each forward biased silicon diode drops about 0.7 volts.

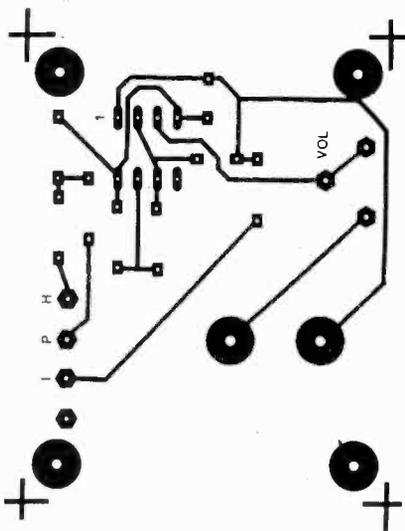


Fig. 2. Here's a template of the board layout used by the author in the production of his prototype unit. For those who choose not to etch their own boards, a printed-circuit board can be purchased from the supplier given in the Parts List.

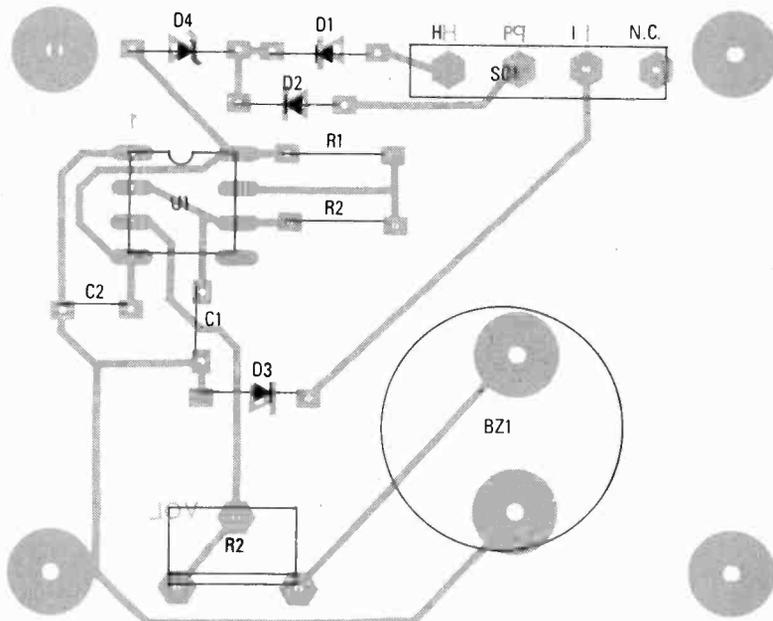


Fig. 3. Assuming that you've opted to go the printed-circuit route, using the foil pattern shown in Fig 2, assemble the components on that board using this diagram as a guide.

PARTS LIST FOR THE LIGHT WARNING SYSTEM

- U1—555 oscillator/timer, integrated circuit
- D1-D3—1N4001 1-amp, 50-PIV (or similar) rectifier diode
- D4—Zener diode, see text
- R1, R2—10,000-ohm, 1/4-watt, 5% resistor
- R3—20,000-ohm, PC-mount, trimmer potentiometer
- C1—0.005-μF, 100-WVDC, mylar capacitor
- C2—0.1-μF, 25-WVDC, ceramic-disc capacitor
- BZ1—Piezo buzzer (Panasonic part No. EFB-RD or similar)

- SD1—3-position, enclosed terminal block (Mouser part No. ME153-2103)
- Printed-circuit or perfboard materials, enclosure, IC socket, splice connectors, wire, solder, etc.
- Note:** The following items are available from BALLCo, Inc., PO Box 1078, Snellville, GA 30278-1078; Tel. 404/979-5900; printed-circuit board (part No. 881101-A) \$9.95; complete kit of parts (excluding case and terminal block) \$14.95, postage paid. Georgia residents must include appropriate sales tax. Please allow 6 to 8 weeks for delivery.

Construction. The system can be assembled on a small piece of perfboard or on printed-circuit board. For those who choose to go the printed-circuit route, a full-size template of the PC artwork is shown in Fig. 2. Or, if you're not into etching your own boards, a printed-circuit board can be purchased from the supplier given in the Parts List.

Once you've obtained the parts outlined in the Parts List, assemble the project using Fig. 3 as a guide. When installing the semiconductors, be sure
(Continued on page 99)

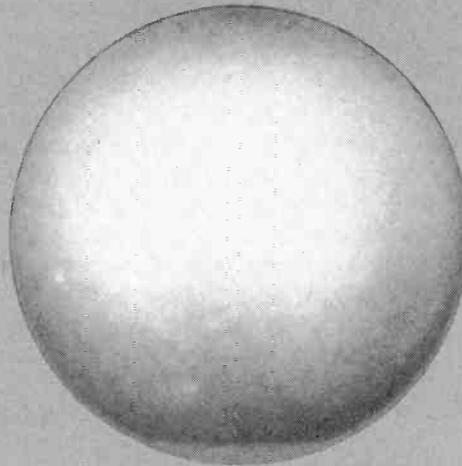
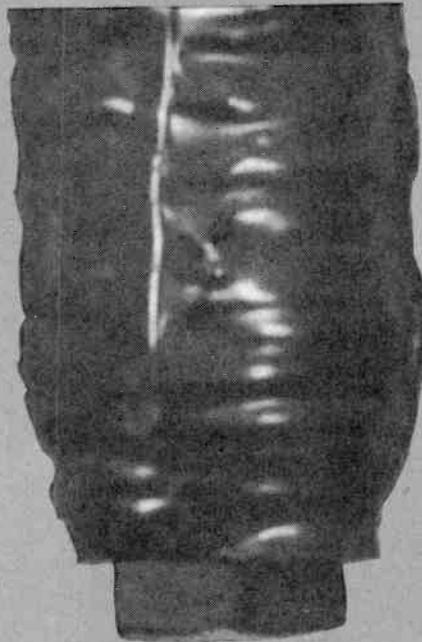
Overcoming the pull of gravity has long been a dream of the scientific community, so much so that countless experiments about it have been conducted over the years. Many of those experiments have dealt with reversing the gravitational effects of the Earth's magnetic pull to free large masses for space travel.

The "Anti-Gravity" Generator described in this article will not send some object hurling through the endless realms of space, but it will give the appearance of having overcome Earth's gravitational pull. The project incorporates a hollow plastic ball with a permanent magnet placed inside and a feedback-controlled electromagnet. When the electromagnet is under power and the ball is brought near it, the ball can be made to float, appearing as though an anti-gravity condition exists.

The feedback control, consisting of both an IR transmitter and detector circuit, is used to influence the amount of energy delivered to the electromagnet, and thereby its magnetic strength. The IR transmitter and receiver are placed so that if the ball is pulled within a certain distance of the electromagnet, it blocks some portion of the IR signal, which reduces the amount of energy picked up by the receiver. That, in turn, causes the pull of the electromagnet to be reduced so that the ball drops out of the transmitter/receiver's line-of-sight, keeping the ball suspended in mid-air creating the illusion of anti-gravity.

Circuit Description. Figure 1 shows a schematic diagram of the Anti-Gravity Generator. The infrared transmitter consists of a 555 oscillator/timer (U3), and an infrared-light emitting diode (LED1). Timer U3 feeds a pulsing signal to LED1. The output frequency of U3 (and therefore the pulse rate of LED1) is determined by R10 and C4. Resistor R8 is used to limit current to LED1.

The receiver consists of a solar cell (PC1), two op-amps (U1 and U2), and a Darlington amplifier made from two discrete transistors (Q1 and Q2). Op-amp U1 is configured as a current-to-voltage



The "Antigravity" Generator

*Astound and amaze
your friends
with this
gravity-defying
project!*

BY VINNEY VOLLONO

converter. Infrared light picked up by PC1 is converted to an electrical signal and fed to the non-inverting input of U1 at pin 3. Because the non-inverting input of U1 is tied to the negative lead of PC1, its output at pin 6 is negative.

Resistors R1 and R2 form a voltage divider and the feedback loop to U1's inverting input to control the gain of the op-amp. The output of U1 is fed through R3 to the inverting input of U2 at pin 2. Resistor R4 sets the gain of U2, while C3, R6, and R7 set the hysteresis to control the oscillations. The output of U2 is fed to the base of Q1, a TIP41A power transistor, through R5. Resistor R5 limits current to the base of Q1.

Transistors Q1 and Q2 control the flow of current to the electromagnet. When the output of U2 is high, that high causes Q1 to turn on, placing a high at the base of Q2. That high causes Q2 to turn on, grounding one end of the electromagnet, turning it on.

Power for the Anti-Gravity Generator is provided by an unregulated dual (\pm) 12-volt power supply, consisting of T1, BR1, C1, and C2. The center tap of T1 is used as a ground, while the other two leads connect to the AC inputs of BR1. Capacitors C1 and C2 are used to filter the output of BR1.

Note that the schematic diagram contains a resistor labeled R_C . That unit may or may not be necessary for the proper operation of the project. If the impedance of the electromagnet is lower than about 30 ohms, inclusion of that resistor will restrict the flow of current to protect the Darlington amplifier and the electromagnet.

Design Variables. Because the circuit needs all conditions to be just right to create the anti-gravity effect, we need some way of offsetting the electromagnet and certain other components. The height of the electromagnet should be adjustable to help compensate for the weight of the ball and the strength of the permanent magnet within the ball.

Another factor in building the Anti-Gravity Generator is the size of the unit that you decide to build. Depending on how large you intend to build the project, the IR emitter and

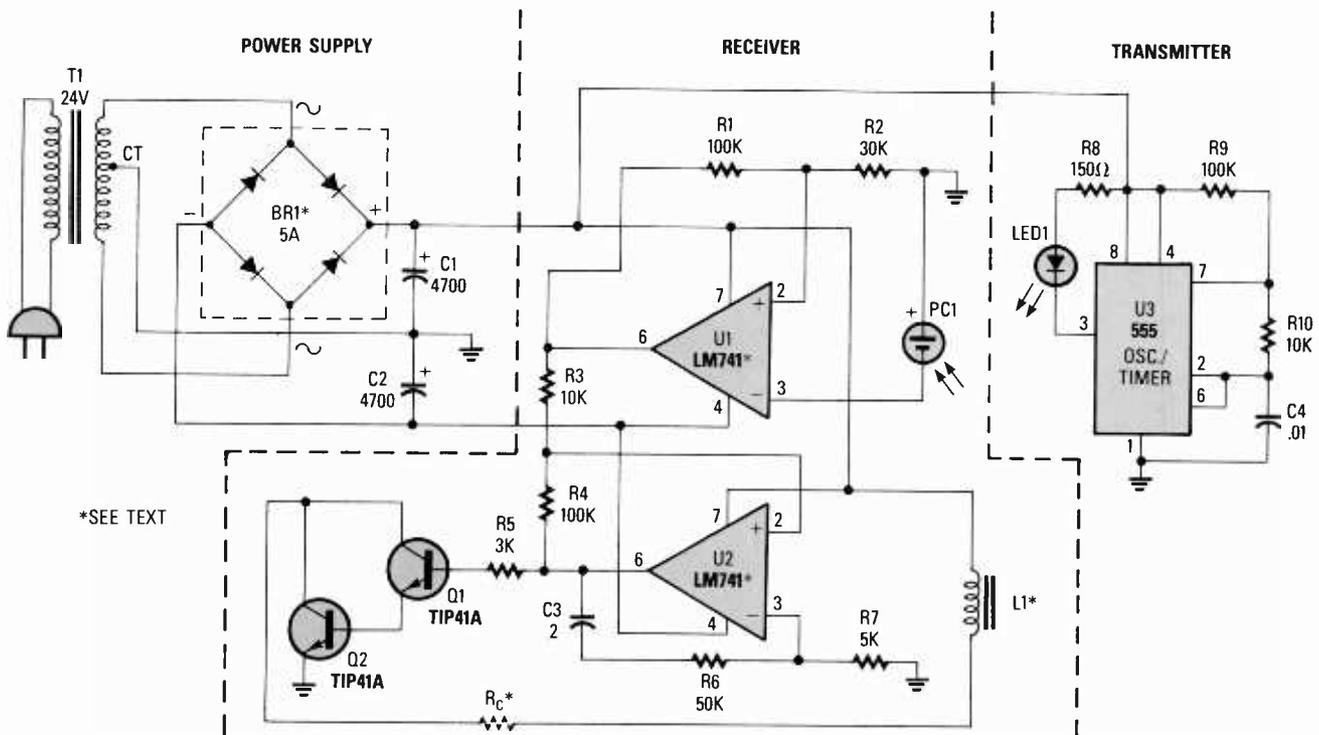


Fig. 1. The Anti-Gravity Generator is really a rather simple circuit, built around several readily available components. In fact, the only component that's not an off-the-shelf item is L1, which you must wind yourself.

receiver will need to be focused accordingly. In the author's prototype, lenses are used because the unit is fairly wide, placing the receiver and transmitter unit a sizable distance apart.

If you wish to build yours only six inches wide, you may not need to use lenses. The reason is that the farther the transmitter and receiver are apart, the more the infrared light is dispersed (spread out). The thinner (more concentrated) the beam, the more accurately the receiver circuit can sense the position of the ball.

A dispersed beam provides much less control, resulting in the anti-gravity effect being much more difficult (or, more likely, impossible) to achieve, because of the lower levels of IR energy striking the receiver. In addition, a dispersed IR beam will be hard to block. Those factors must be taken into consideration or the project will not operate.

While two 741 op-amp IC's were used for U1 and U2, both units can be replaced by a single 1458 dual op-amp.

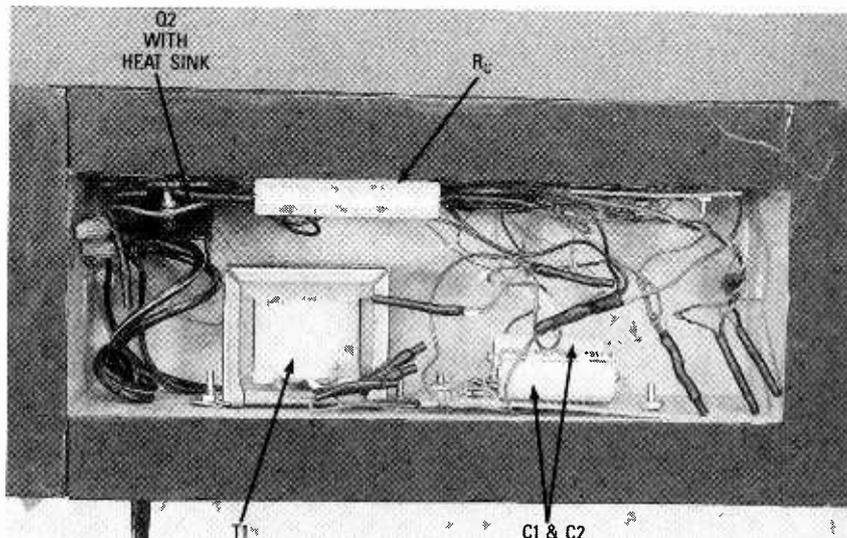
Construction. The author's prototype was built on three small sections of perfboard. When assembling your Anti-Gravity Generator, follow Fig. 1 as a guide. Transistor Q2 should be heat-sinked to prevent it from overheating

during operation. The bridge rectifier, BR1, can be made from discrete diodes, or a pre-packaged bridge can be used. Just make sure that the rectifiers have the proper current rating. After the three perfboard circuits have been assembled, place them to the side for a while and move on to the rest of the project.

The electromagnet (L1 in Fig. 1) is a home-made coil wound on a half-inch diameter, 6-inch long bolt. Two layers of black electrical tape are placed

over the bolt, and the coil is wound on top of the tape. The author wound about ¼-pound of 28-gauge magnet wire onto the bolt, covering only about three inches of the bolt at the head end.

The easiest way to wind the coil is to place the bolt in a hand drill, wind three or four turns onto the bolt to get things started, and let the drill do the rest. DO NOT cut off the extra bolt length, and be sure to leave enough lead length to allow the coil to be attached to the receiver circuit board. The remaining three inches of the bolt



Here's an inside view of the sectionalized circuit mounted in the base of the Anti-Gravity Generator. The large high-wattage resistor (R_c) is connected in series with the electromagnet (L1) to bring L1's impedance up to at least 30 ohms.

is needed to make height adjustments on the electromagnetic and secure it in place.

When L1 is finished, it should have an impedance of about 30 ohms. The electromagnet has a great effect on the current through the Darlington pair. If the coil's impedance is too low, both

PARTS LIST FOR THE ANTI-GRAVITY GENERATOR

SEMICONDUCTORS

U1, U2—741 op-amp (or 1458 dual op-amp, see text), integrated circuit
 U3—555 oscillator/timer, integrated circuit
 BR1—5-amp, 100-PIV bridge rectifier (see text)
 LED1—Infrared light-emitting diode

RESISTORS

(All resistors are 1/4-watt, 5% units)
 R1, R4, R9—100,000-ohm
 R2—30,000-ohm
 R3, R10—10,000-ohm
 R5—3000-ohm
 R6—50,000-ohm
 R7—5,000-ohm
 R8—150-ohm

CAPACITORS

C1, C2—4700- μ F, 16-WVDC, electrolytic
 C3—0.2- μ F, 50-WVDC, ceramic disc
 C4—.01- μ F, 50-WVDC, mylar

ADDITIONAL PARTS AND MATERIALS

L1—See text
 T1—25-volt, center-tapped, 2-amp transformer
 PCI—Solar cell, 1/2-inch square, 5-volt, 55-mA
 PL1—117-volt AC plug with line cord
 Perfboard materials, 6-inch long, 1/2-inch thread bolt and nut, 1/4-pound of #28 magnet wire, two 19mm diameter convex lenses, Samarian cobalt magnets, hollow plastic ball, wood, electrical tape, heat sink, IC socket(s), hook-up wire, solder, hardware, etc.

Note: For technical assistance on the construction of the Anti-Gravity generator, call 203/672-0123 (weekday mornings only).

The following items are available from Star Electronics, PO Box 2233 Times Square Station, New York, NY 10036; solar cell, \$5.; Samarium cobalt magnet, \$4. each; plastic ball with magnets, \$12.; 24-volt, 1-amp, center-tapped transformer, \$21.; kit of parts (does not include wooden frame and housing), \$24.95. Add \$3.50 for shipping and handling per order. New York State residents add 8.25% sales tax. Please allow 6 to 8 weeks for delivery.

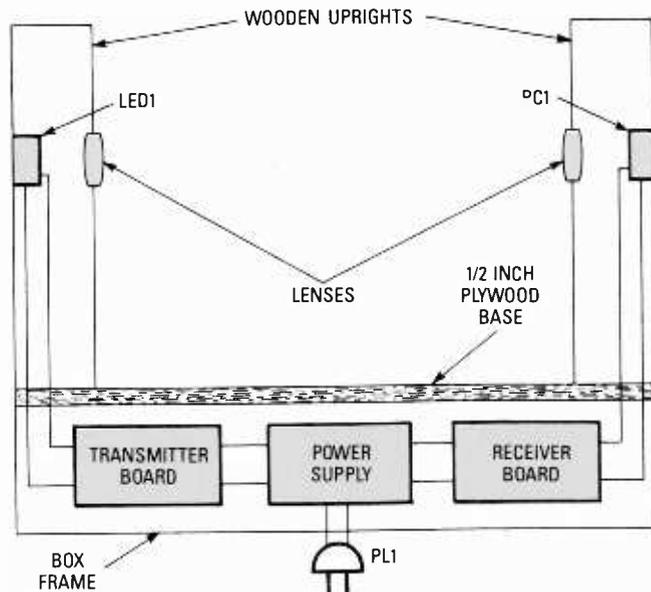


Fig. 2. In the author's prototype, the wires between the receiver and transmitter boards, and the electromagnet (L1), the solar cell (PCI), and the IR diode (LED1) were run through ducts drilled into the wood uprights, and cross brace.

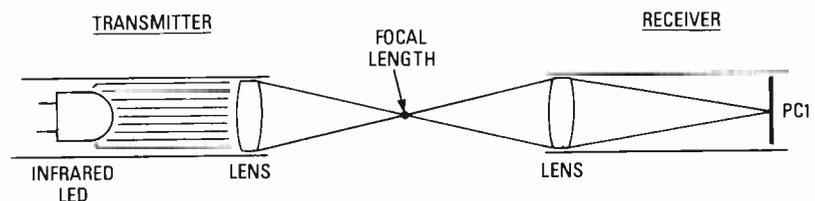


Fig. 3. The transmitter, receiver, lenses (if used)—which are located in the uprights—must be properly aligned and focused in order for the Anti-Gravity Generator to function.

the electromagnet and the Darlington pair will overheat. The impedance of the coil can be compensated by placing an appropriate resistor (R_C in Fig. 1) in series with the coil, as previously mentioned.

After the coil has been wound onto the bolt, cover it with several layers of electrical tape to keep the wire from unraveling. Once that's done place the electromagnet coil to the side for a while and move on to the next stage of construction.

The Frame. The author built the frame for his prototype from wood because it is easy to work with. However, you can build the frame from whatever materials you may have on hand—for example, acrylic plastic can be used for a snazzier look. For obvious reasons, metal should not be used. Use your own imagination.

Figure 2 shows the construction details of the frame. Start by taping two pieces of the framing material together. Those two pieces of wood will be used to form the uprights (the frame-work where the IR emitter and

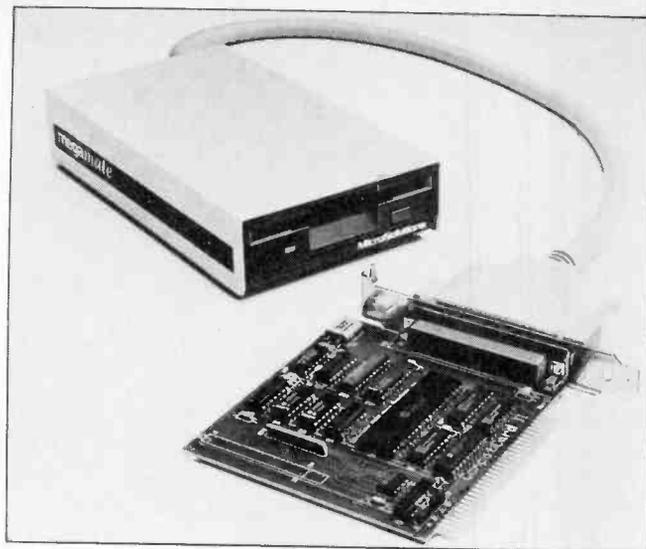
solar cell are to be located). The author used 11 × 2-inch lumber. With the lumber still taped together, cut them to equal lengths and sand the ends flat smooth. Drill a half-inch hole through both wood pieces at about 4-1/2 inches from what will hereafter be considered the top of the upright.

As far as the wiring goes, the author drilled holes straight through the wood with an 18-inch drill bit in order to conceal the wiring. That is not necessary; you could just as easily tape the wires to the outside of the wood if you wish. Drill a hole lengthwise through the centers of each piece of the framing wood.

Alignment. The infrared transmitter and receiver must be aligned in order to permit proper operation. The author used lenses in his prototype (see Fig. 3) because of the distance between the transmitter and the receiver. Note that the lenses must be focused for maximum IR energy to strike the receiver.

Place LED1 into the hole in one piece of the framing wood and the solar cell

(Continued on page 98)



CIRCLE 63 ON FREE INFORMATION CARD

MICROSOLUTIONS MEGAMATE 3.5 INCH DISK SYSTEM

*1.4 megabytes is a big chunk of diskette
memory, and you can use it anyway you want!*

Miss Pruitt, my eighth-grade English teacher, always claimed that "versatile" was one of the most overused words in the English language. Much too often, the budding composition writer talks about a versatile tool, a co-ed would talk about her beau being a versatile athlete, and a reviewer of products raves about a versatile gadget. Well, that's exactly what this reviewer will be doing about the *MicroSolutions Megamate* 3.5-inch diskette-drive system.

Megamate provides compatibility

with your IBM PC; XT; AT; or 100-percent compatible, clone computer and any other IBM computer using 3.5-inch diskettes. You can interface with both 720KB and laptop diskettes, and 1.4MB PS/2 diskettes. Megamate determines what format the diskette is using. The Megamate drive is housed in a compact, flat, pro-type steel case that rests on top of your computer housing and connects to a half-size expansion slot in your IBM type computer. Megamate comes complete—all you supply is the screwdriver. The only cable for the

Megamate system connects between the computer and the external case.

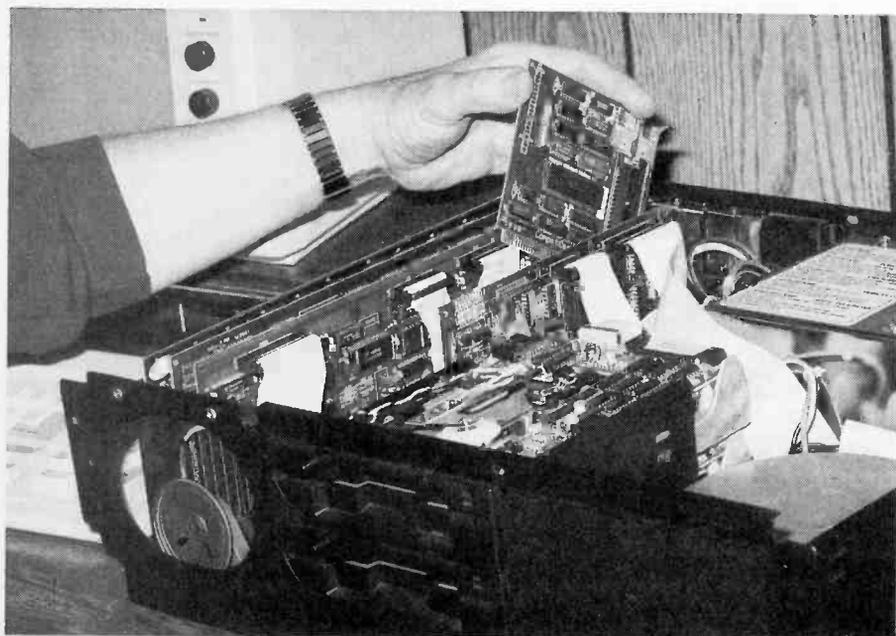
Megamate requires an IBM PC, XT, AT, or compatible clone with at least 128K memory; PCDOS or MSDOS, version 2.0 or above; and one half-size expansion slot. You'll need a screwdriver to install the card.

What's in the Box. When we buy a new plaything, rapid installation and rapid application is a user's demanding requirement. That's what the Megamate system delivers.

The card installation is simple! The computer is *de-powered*—power cord disconnected. Out come a few screws, and the housing's cover can be removed. A blank metal face plate is then removed from the mating site of an empty expansion slot on the motherboard. (The slot next to the power supply on XT's should not be used.) Secure the card in place using the screw extracted to remove the face plate. Check that the card is seated squarely and firmly in the expansion slot. Close up the housing, replace all screws, and you're almost done.

Plug the Megamate cable from the drive into the jack exposed on the rear panel of the computer. Secure the connectors by turning the retaining screws until they are finger tight. Now connect the power cord and any cables that may have been removed for convenience sake. (The printer was

(Continued on page 100)



The Megamate card is inserted into an unused expansion slot in a PC XT clone computer. The 3.5-inch diskette drive connects to a jack on the rear panel and requires no power plug.

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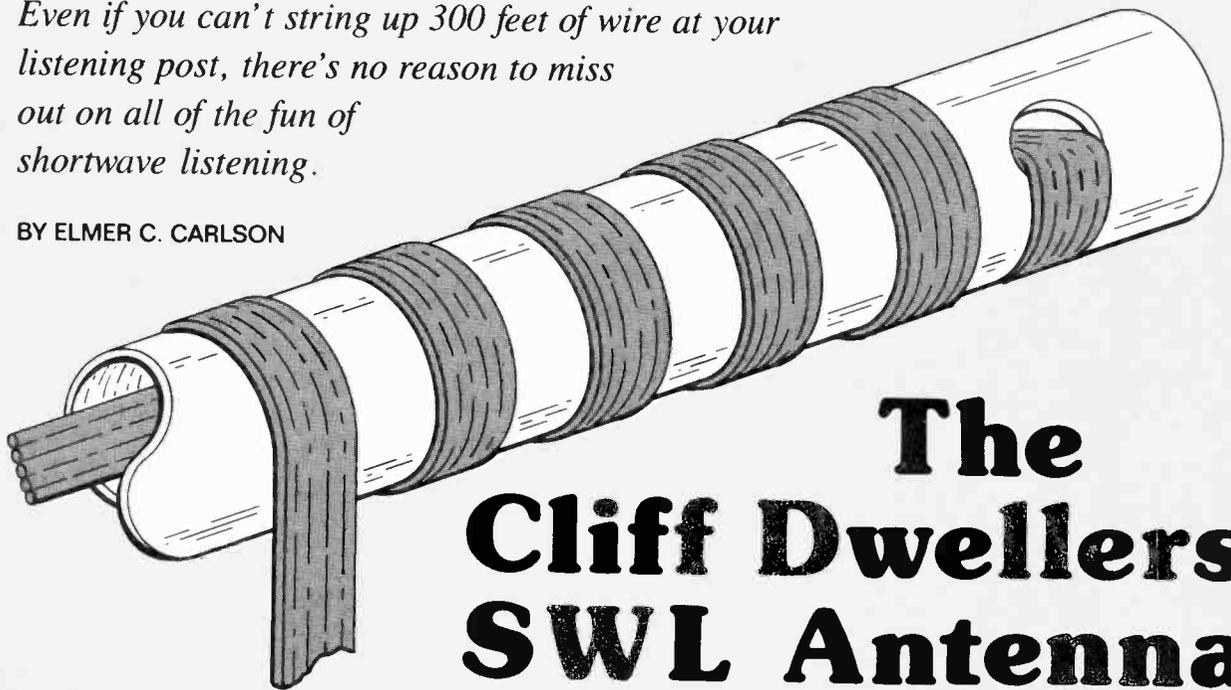


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5024

Even if you can't string up 300 feet of wire at your listening post, there's no reason to miss out on all of the fun of shortwave listening.

BY ELMER C. CARLSON



The Cliff Dwellers SWL Antenna

Urban DX enthusiasts are faced with many problems in setting up ham shacks within the confines of the limited space allotted to them. Probably the most perplexing of those problems has to do with the antenna—in particular, how much space can be dedicated to the antenna system.

The long-wire antenna, long-considered one of the most cost-effective RF pick-ups, has for many years been out of the question for urban dwellers. Electrical codes, neighborhood esthetics, and most lease clauses, severely limit (or prohibit) outdoor antennas. And except for rural areas, long-wire antennas have just about disappeared—even hobby-communications retailers no longer display equipment suitable for quality broadcast-band DX'ing and SWL'ing (short-wave listening).

But don't give up—for the *Cliff Dweller's SWL Antenna* described in this article does the job of conventional long-wire antennas, while taking up relatively little space. At as little as 7-feet long, this miniature antenna can be (semi-permanently) hidden behind the drapes, on top of a wall-length bookcase; temporarily be set up on a porch, patio, balcony; or attached to a window frame or window sill. Each situation is different and

must be handled accordingly. And it's capable of pulling in signals between 150 kHz and 30 MHz.

A Little Background. Receiving antennas are passive devices—they just hang around and collect airborne signals. Despite that, the antenna can come in many forms including dipoles, beams, loops, verticals, and long wires. The simple long-wire (or inverted-L) is the best known member of the family of "flat-top" antennas. It is one of the earliest antenna designs, and was most commonly used in the days be-

fore high-gain vacuum tubes, and loop antennas.

An antenna is a long wire only when it is long in terms of wavelength. In other words, just being "long" relative to something like available space, doesn't make a wire an effective collector of radio signals. For instance, at 3.8 MHz (75-meter amateur band), one wavelength is 259 feet long.

That's a lot of wire, to say the least. But our antenna gets around that by using a couple of tricks. For one, the antenna is *helically* wound. That is, instead of being just straight wire, the

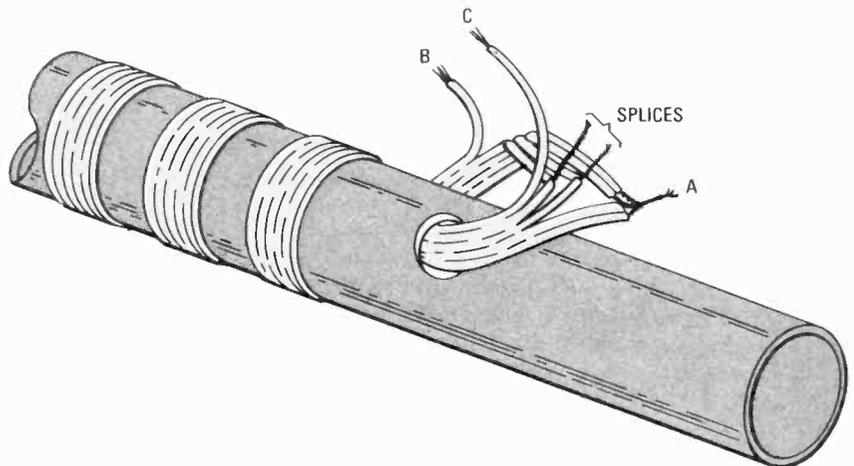


Fig. 1. Once the 5-conductor cable has been wound onto the pipe, splice and solder the ends of the conductors, and insulate with shrink tubing or wrap with tape. Tuck the connections into the holes for a neat-looking project.

antenna's conductors are coils, or inductors. By using inductors, and by introducing mutual inductance by folding the conductors back on themselves between three and five times, depending on its configuration, the antenna is much longer electrically than it is physically. That means that it does the job of a much longer unit.

Just how long is its electrical length? I really don't know! However, it seems to me that the antenna stepped out Boy-Scout fashion always out-performs the one measured out to the last millimeter anyway, and this one is no exception. For frequencies between 150 kHz and 30 MHz, the Cliff Dweller's SWL Antenna performs better than any antenna I've ever used for broadcast-band DX'ing or SWL'ing, including many roof-top antennas I've strung up over the years since my high school days. In fact, Moscow, Egypt, and Israel have never come in clearer, and with less fading.

Experimenter's Delight. There are many theories on how antennas work—some are extremely complicated and require mathematics that would choke a dedicated number-crunching computer. However, most of the time antennas seem to have a "theories-be-dashed" attitude about them. Their characteristics seem to defy any logical or theoretical explanation. Of course, antennas don't really have a mind of their own. Instead, you have to realize that everything near or around the antenna, or in the line-of-sight with a desired signal, will directly effect performance. The closer the object and the better its conductivity, the greater the effect it has on the antenna. And intensifying the problem is the fact that theories usually deal with antennas that exist in that fairyland of "free space," a place that's very hard to find in our modern, cluttered world.

Because of that, antennas are often an experimenter's delight, or torment. In addition, there are some "twists" with this unit that makes things more interesting. For example, there are a couple of ways of hooking up the antenna. Which one do you use? Why, the one that works best, of course. This is an antenna for experimenters—so experiment! The "parts" are cheap, to say the least—just a 7-foot or longer length of pipe and some 5-conductor TV-antenna rotor cable (a 100-foot roll, available from Radio Shack as part

number 15-1201, will be more than enough)—and there is nothing to burn out. Remember, this is a *receiving* antenna, not a *transmitting* one. While resonance is absolutely critical in a transmitting set-up, the key here is getting the best performance.

Construction. The first thing you must do is decide where you are going to put the antenna—where you are going to use the antenna and where you are going to store the antenna. You don't want an 8 foot length of PVC pipe when the ceiling-to-floor height is 8 feet. You would scrape the ceiling putting the antenna in place (and you know who would be giving you "you know what" if you scraped the ceiling). That's why my antenna had a 7-foot length. But if you intend to hide the antenna behind a 9-foot drapery rod, then a 9-foot length of PVC might be more suitable for your antenna's construction. Select a pipe with an inside diameter of at least $\frac{3}{4}$ inch to make threading the cable easier.

There are two basic rules to follow in building the antenna. One is that you need a minimum of 7 feet of pipe; the



An indoor antenna that anyone could love, the Cliff Dwellers SWL Antenna could also be hidden behind a drapery or on top of a bookcase.

second is to maintain a spacing of 12 turns of cable per foot of pipe. That spacing will place about 39 inches (or about 1 meter) of cable per each foot of pipe.

No matter what length of PVC pipe you have decided to use, the first thing you must do is find the center point of the pipe. From the center point measure $3\frac{1}{2}$ feet in each direction. Mark those two points with a sharp-pointed tool, such as a scribe, awl, or ice pick. Before you put away the measuring tape, measure and use a marking pen to mark off 1-foot sections between the two end points.

Next, drill a hole, at least a half-inch in diameter at each end point. Only drill through one wall of the pipe, not the opposite one. Clean off any rough or sharp edges of the holes, both inside and out. If you don't make the edges smooth, they'll snag the wire and make it difficult to pull through the center of the pipe, or possibly strip them in an undesirable place—rendering all of your efforts useless.

Measure and mark about $7\frac{1}{2}$ feet of 5-conductor flat antenna-rotor wire. Try to put the end of the wire in the hole that will be at the top of the pipe, or the end farthest away from where you want the lead to the receiver. If the wire does not feed through the hole and down the length of the pipe easily, it may be necessary to enlarge the hole or pull the wire through the hole and pipe using a length of cord. A small weight attached to the end of the cord and dropped into one hole will pull the cord through when you stand the pipe up.

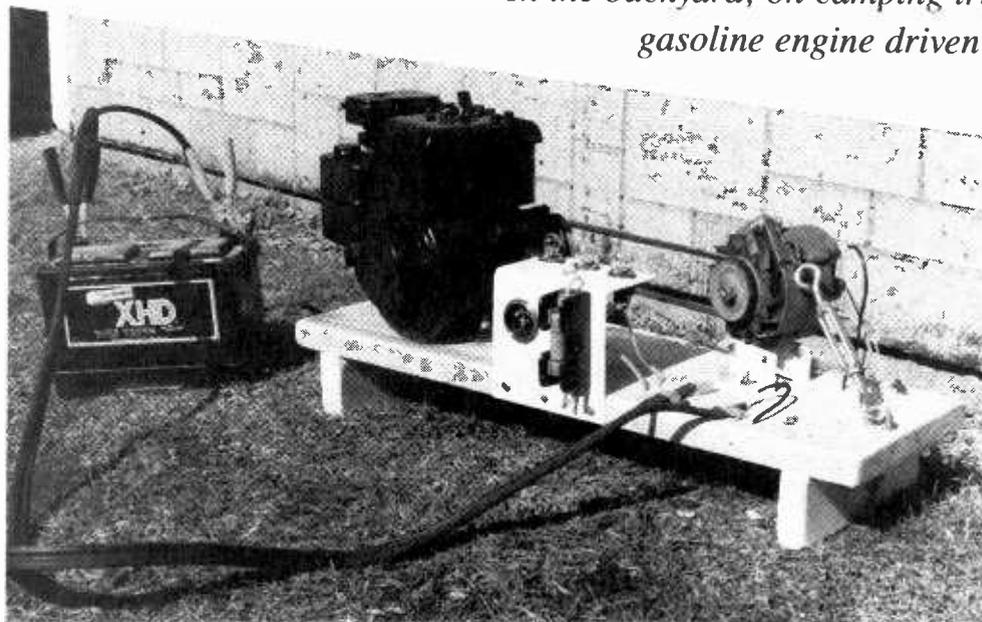
If you can't get help to pull the string and cable through the PVC pipe, tie the loose end of the string to a door-knob and feed the 5-wire cable through the hole and pipe until you reach the $7\frac{1}{2}$ -foot mark on the cable. Once that's accomplished, anchor the end of the cable that is through the pipe at the far end, and feed the loose (near) end through its hole and anchor it, too.

Now, starting from the far end, you can start wrapping the 5-wire cable around the pipe as shown in the lead artwork of this article. Wrap 12 turns around the pipe and position them to reach to the first one-foot mark on the PVC pipe. Wrap a piece of tape around the pipe to hold the winding in place. Wrap another 12 turns around the pipe, covering the next foot of

(Continued on page 106)

In the backyard, on camping trips, or anywhere else, this gasoline engine driven generator can provide for all your electrical needs!

BY JOHN MCDOWELL



BUILD A DC GENERATOR

Most factory-built portable electric generators today are 117-volt AC units that may have a little 8-10-volt DC circuit thrown in, almost as an afterthought. They also cost a bundle. The *Homemade DC Generator* described in this article won't give you AC power—unless you run it through an inverter—but it can crank out 12-volts DC at up to 40 amps, or more.

If it can be used as an emergency power supply, for in-the-field recharging of marine/RV batteries, lighting and recharging for a backwoods cabin, and a variety of other purposes. Aside from those practical uses—it's also fun to build. Should you happen to have an old snowblower engine handy and a used auto alternator of the right kind lying around, you could probably build this unit for as little as \$30–\$40.

Originally intended to recharge banks of batteries for household lighting needs in remote areas, the *Homemade DC Generator* (lacking a regulator) will produce full current without the time-wasting tapering off process used in factory-built generators.

The *Homemade DC Generator* also contains a battery-charging circuit, whose basic design is quite simple: a small, gasoline engine with a horizontal-shaft (such as a Briggs unit) turns a

V-belt that turns an automobile alternator to produce a high DC current, at 12 volts. Running through a fuse and ammeter, the current reaches the battery through booster cables. Everything is mounted on a two-by-one-foot plank, two inches thick. The plank itself is nailed to a couple of two-by-four-inch runners that serve as legs.

As shown in Fig. 1, the engine and alternator are situated so as to oppose each other rather than both being on the same side of the plank. That's done because most small engines turn counterclockwise and most alternators are made to turn clockwise. So, the engine and the alternator must oppose each other. The engine and the alternator must be mounted somewhat off-center, as shown in Fig. 2—a top-side view of the engine/alternator assembly.

The Engine and Alternator. The motor used needs to be a horizontal-shaft engine, such as those used on snowblowers and some rototillers, with a horsepower range of from 2½ hp to 5 hp. The engine should have a standard ½- or ¾-inch shaft. For my charger, I obtained a used 4-hp snowblower engine from a lawnmower repair shop (at a cost of only \$65.00). I also bought a 3½-inch pulley (for \$2.69) to mount on the engine's shaft.

The alternator needed for this par-

ticular design must be an older Delco type from a late 1960's or early 1970's GM automobile. We want an alternator that does not have a built-in regulator; the older Delco's fit the bill. You can identify an unregulated Delco unit because it has a recessed pocket in the back (see Fig. 3) with two sockets placed side-by-side that are designed to mate with vertical-prong plugs; the regulated Delco's have sockets designed for horizontal-prong plugs—avoid them.

I lucked out when I discovered an old Delco alternator of the proper type lying around the garage. If you have to buy one, you can probably get one from an auto salvage yard, or discount-department or auto parts stores. You'll also need a wired plug (called an alternator harness) to fit into the two-pronged recessed socket on the back of the Delco. (I purchased a package of two at an auto-parts store.

Mounting. Before drilling any holes in the plank, position the engine and the alternator on the plank to get an idea of about where they'll have to go to fit on the board. Then buy a fanbelt of the proper length to bridge the distance between the two. Mount the engine first, using four hex bolts of suitable length to go through the plank and fasten them on the bottom with washers, lock washers, and nuts.

MATERIALS LIST FOR THE HOMEMADE DC GENERATOR

Engine 2.5 to 5 hp
 Alternator
 Ammeter (0-60-amps, see text)
 Booster cables
 Sheet metal
 Angle iron
 Fanbelt
 Automobile taillight lamps
 Wiring harness, wooden plank, turn-
 buckle, pulleys, solder, hardware, etc.

maintained by a 3-inch turnbuckle that runs from the top of the alternator to a hook-eye fastened in the plank.

The alternator has one top mounting hole, which is threaded for a $\frac{5}{16}$ diameter bolt. Screw a $\frac{5}{16}$, $\frac{1}{2}$ -inch long bolt into the top hole and use that as a fastening point for the turnbuckle running from the plank.

Once the assembly is complete, start up the motor, tighten the tension on the fanbelt, while making sure that both of the pulleys and the fanbelt are running smoothly. It's a good idea to also build a cover (as shown in Fig. 6) for the pulleys and belt. The cover used in the prototype was made from sheet metal.

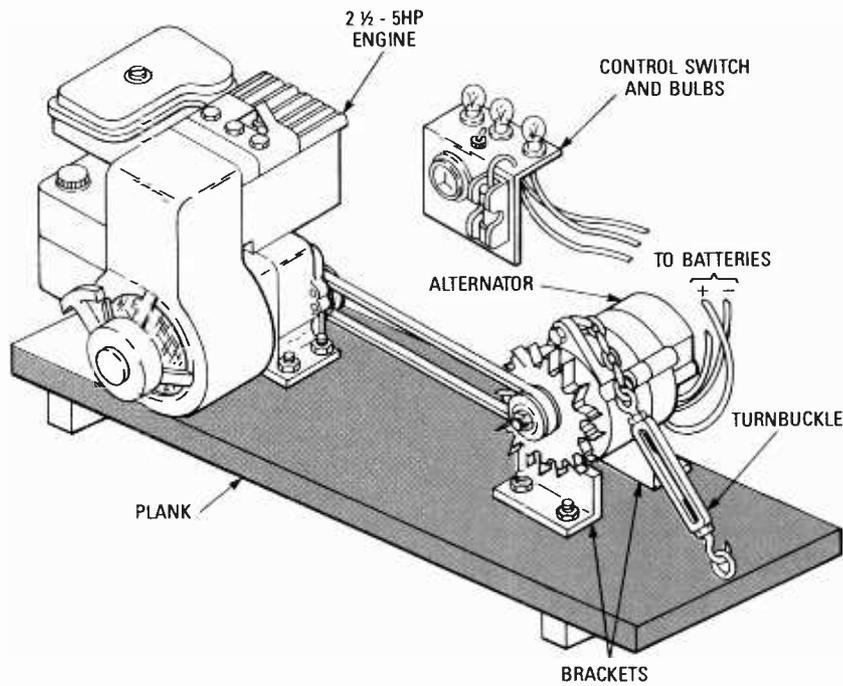


Fig. 1. Here is a general layout of the Homemade DC Generator.

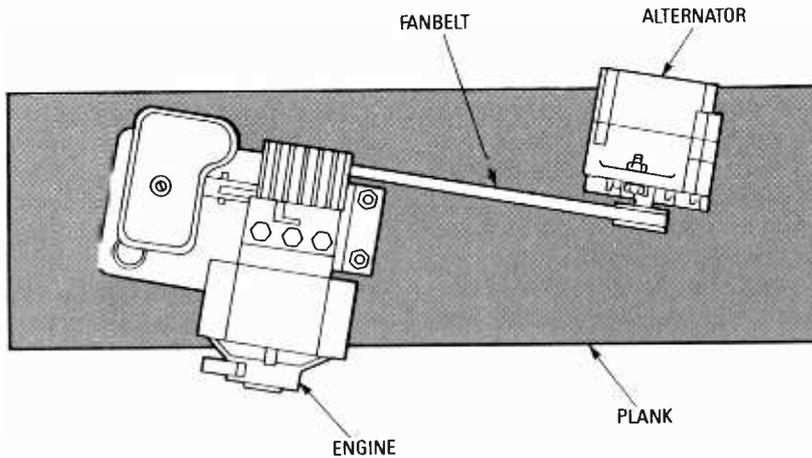


Fig. 2. As shown by this overhead view, the engine and alternator are mounted somewhat off-center, with their drive shafts opposing each other.

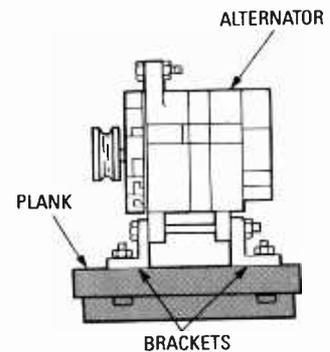


Fig. 3. This illustration shows the two types of sockets likely to be found on the alternator. The one on the left (with its vertical prongs) is suitable for this project, while the one on the right (having horizontal prongs) should be avoided.

The alternator is mounted on brackets designed to let it pivot on a long lower bolt, enabling the tension on the fanbelt to be increased or decreased. For those brackets, the au-

thor used two 3-inch lengths of angle iron ($1\frac{1}{2}$ by $\frac{1}{2}$ inches). As shown in Fig. 4, three $\frac{3}{8}$ -inch holes had to be drilled in each 3-inch length of angle iron.

The brackets, once bolted to the plank, hold the alternator an inch or two above the wood plank. The alternator is held in place between the brackets by a long bolt that goes through its lower mounting hole. When mounting the alternator and its brackets, it is important to get a perfectly straight alignment between the pulley on the alternator and the pulley on the engine; otherwise the fanbelt may bind up, wear out, or come off while the engine is in operation.

By pulling the alternator so that it pivots away from the engine, the fanbelt between the two pulleys can be kept taut. The tension on the fanbelt is

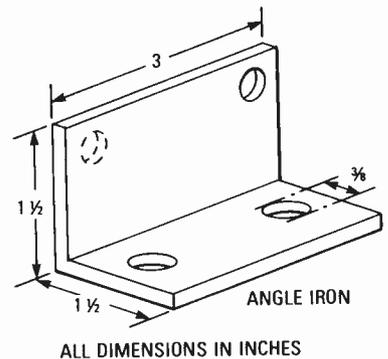


Fig. 4. Mounting brackets for the alternator can be formed from short lengths of angle iron. The alternator is then mounted to the plank using brackets, such that the alternator can be pivoted toward or away from the engine to maintain the tension on the fanbelt.

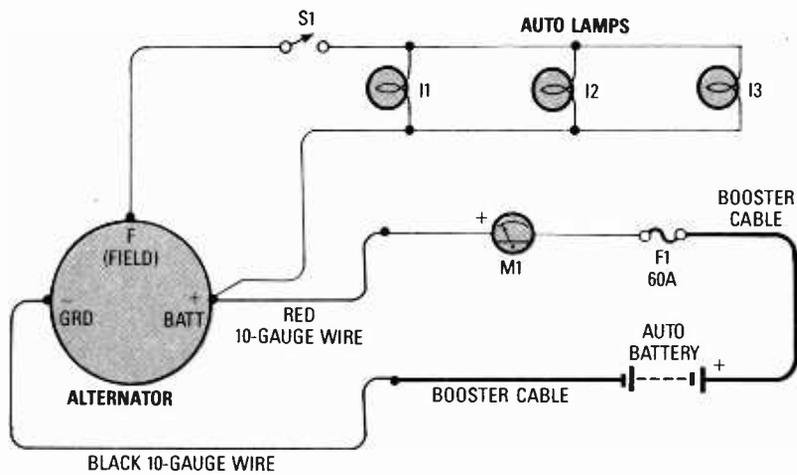


Fig. 5. The amount of charging current delivered to the battery is directly related to the amount of current fed to the F terminal of the alternator. Automobile tail lamps are used to set the level of output current: using one lamp provides the minimum current output; all three lamps would provide the maximum current output.

Wiring the Charger. The next step is fairly simple, but must be done correctly to avoid damaging the alternator or the other parts. Just follow the wiring plan as laid out in Fig. 5. There are only three electrical terminals on the back of the alternator for you to be concerned about.

One terminal has a red plastic insulator and is marked BATT for positive connection. The terminal opposite it has a smaller nut and no insulator. That terminal may be marked GRD for ground (the negative connection). Those two terminals connect to the battery terminals, and from there to the alternator.

An ammeter—0–50-amps is a good choice—and 60-amp fuse are connected in the line that runs from the positive terminal of the alternator to the battery. If you can't find a 0–50-amp meter at the right price, a 0–30-amp meter from an auto parts store will suffice. You'll also need a ceramic fuse holder for the fuse. An electrical supply house or an electrical contractor should have one.

The third terminal on the alternator that you need to deal with is the F (field) terminal—a recessed two-prong socket. Each prong has a letter stamped underneath or near it. Only the prong marked F will be used; the other prong (marked R) will not be used. Cut off the wire that runs to the R prong on the wiring harness that fits into the recessed socket—it won't be needed and will only get in the way.

It is the F terminal that tells the alternator when to produce current and how much. Feeding a little positive current into the F terminal causes the alternator to produce lots of charging

current. The more current fed to the F terminal the more the alternator produces and the harder it is to turn the shaft.

With everything in operation, you can hear the strain of the engine as the power to the F terminal is increased. That means that your homemade power-plant is under load, working well, and putting out the "juice."

A line run from the alternator's positive terminal to its F terminal would cause it to produce too much power, and possibly overheat. But, by placing some kind of resistance in the line, only part of the positive current is allowed to reach the F terminal, keeping things within manageable levels.

One to three auto tail-lamps (as shown in Fig. 5) can be used to provide that resistance. To use that method, three auto-lamp sockets are connected in parallel, and connected in series with a switch (S1). That series/parallel combination is wired across the F and BATT terminals. As an alternative to using auto lamps, you might instead use a 25-ohm, 150-watt rheostat.

Inserting one bulb in a socket causes the alternator to produce a certain amount of current; insert two bulbs or all three and you can produce even more power. By using different types of 12-volt parking or backup bulbs (they vary in wattage), you can set the amount of DC current that the alternator produces. Because the alternator has no regulator, it produces the desired amount of current right up until the end, without tapering off as a regulated alternator would. A 3-hp engine powering an alternator can produce up to 35 amps, but would run best putting out 15 or 20 amps. A 5-hp charger runs well at 25 to 30 amps.

The author used 10-gauge, insulated copper wire (red positive and black negative) for the connections from the alternator to the meter and the fuse. An auto booster cable (of the type commonly used to jump start cars with dead batteries) was used for the connections between the battery and the alternator/meter/fuse circuit.

Although the inner copper wire of such cables is also 10 gauge, the

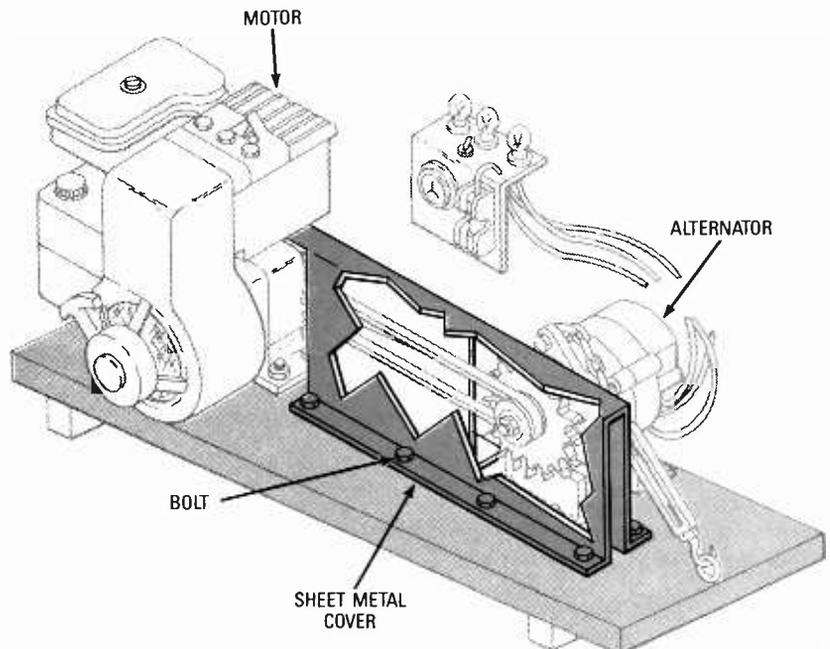


Fig. 6. As a safety measure, it is recommended that a cover for the fanbelt/pulley assembly be fabricated from a piece of sheet metal. Be sure to make the cover large enough to allow free movement of the fanbelt/pulley assembly, without obstructing the free movement of the rest of the project.

heavy rubber insulation on the cables made them too thick and heavy to connect directly to the terminals on the back of the alternator. So the author connected them to short lengths of the smaller, more flexible 10-gauge wire (used in auto wiring). The ends of the wires are connected directly to the terminals on the alternator. Where the heavy booster cables joined the lighter wires, the author used metal straps to fasten them to the plank.

If you plan to use the charger with much longer battery-charging lines—perhaps in a permanent cabin set-up—you'll need to use heavier insulated wire. For instance, you might use 8-gauge insulated copper wire for a run of up to 20 feet; 6-gauge for 30 feet; 4-gauge for 45 feet; and 2-gauge for up to 60 feet. For long wire runs, the fuse should be placed near the battery, rather than on the charger's control panel.

A lot of current passes through those wires and there's quite a bit of vibration when the motor is running; so secure all connections well, using soldered or crimped connectors, or wire nuts or lugs. At places where the wire must make contact with a bolt-like terminal (as on the back of the alternator and ammeter), fasten a stud terminal to the end of the wire. The stud terminal will lie flat under the terminal nut.

For convenience, a control panel (like the one shown in the photos) can be fashioned from a piece of sheet metal. The author used a drill and saber saw with a metal-cutting blade to make cutouts in the panel for the ammeter and lamp sockets. The fuse and fuse holder are also mounted on the control panel, along with S1.

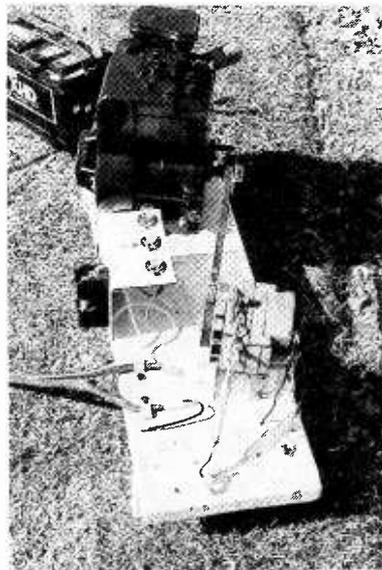
After cutting the sheet metal to size, and making cutouts for the panel-mounted components, make a 90-degree bend in the metal and screw the whole piece to one edge of the wooden plank. To give the set-up a neater appearance, some of the connecting wires can be run under the plank, thereby lessening the clutter topside.

Taking Charge. Once your generator is fully assembled, the procedure for charging a battery is as follows: Before starting the engine, connect the booster cables to the proper terminals on the battery, and start the engine. Adjust the tension of the V-belt by tightening the tumbuckle that secures the alternator.

Place a tail-light bulb into one of the lamp sockets on the control panel. Flip the off/on switch to "on." If the meter shows a charge and the engine lugs down a bit, it's working! If more current is desired, add one or two more bulbs to the sockets on the control panel. But don't get too current hungry and overload your rig.

If the alternator seems to be overheating or the motor is straining, either increase engine speed (to provide more cooling) or reduce the number of bulbs loaded into the sockets.

Use. A high-current charging rate could damage a battery (warp plates or bubble away fluid) if fed to a single RV- or marine-type battery. That's especially true if, due to the lack of monitoring, the battery is allowed to overcharge.



Note the slight angling of the alternator and engine. If the alternator and engine were not mounted in that manner, a wider wooden plank would be needed to accommodate the assembly.

With practice, one can judge, with acceptable accuracy, how long to let the engine run to recharge, say, a 50% depleted battery without damaging it. Don't let batteries run down completely before recharging; recharge them when they're no more than 50% depleted.

Use only one 12-volt auto lamp, of a smaller wattage, in the control panel to reduce the charge rate. Monitor the recharging process carefully, watching for excessive bubbling. If possible, it is best to charge two batteries at once; that divides the amperage that each battery receives. When recharging small RV or marine batteries, it's

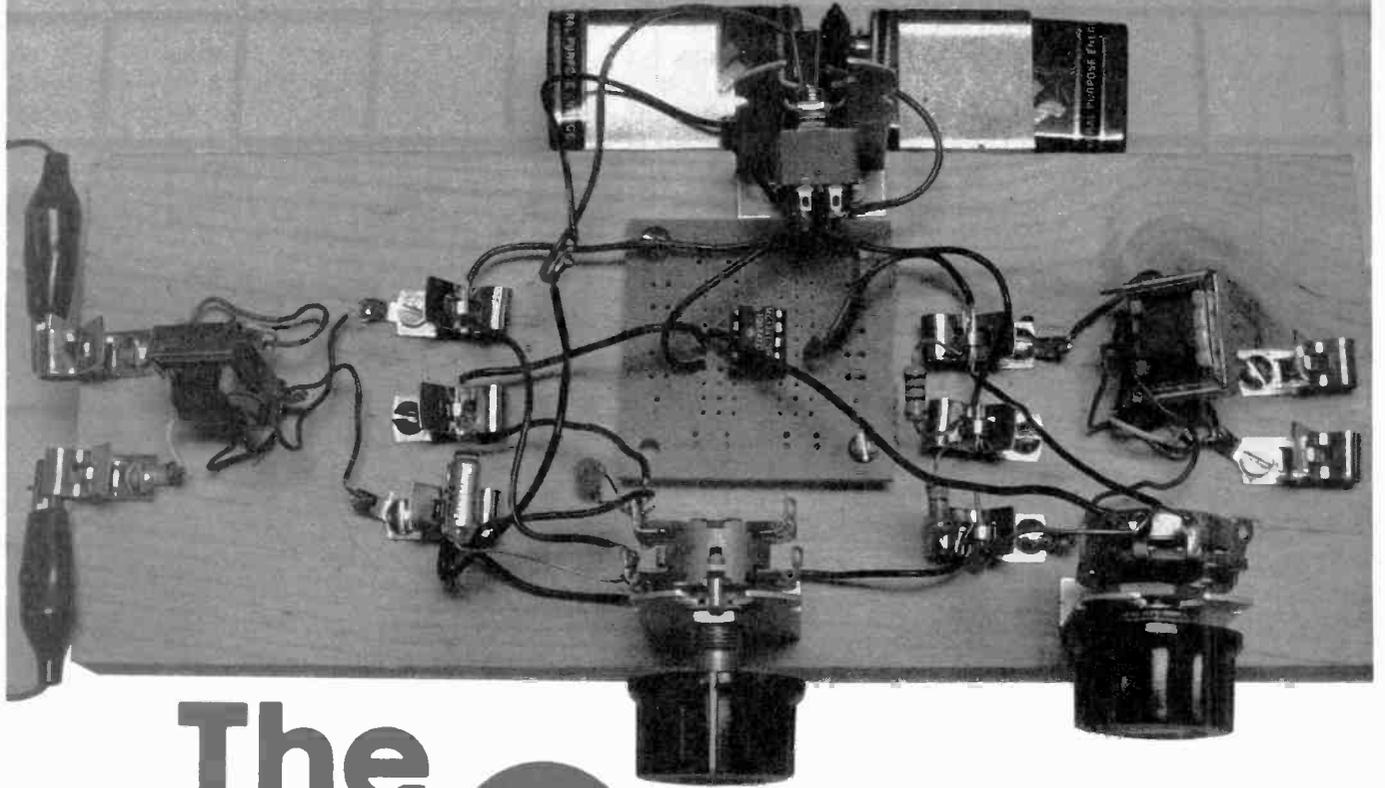
best to recharge them at no more than 20-amps—an even lower rate might be preferable. **Caution:** Do not use the Homemade DC Generator with a regular car battery; they aren't made for deep charging.

Safety Precautions. Do not let children operate or play with the charger, and do not operate it unattended when children and pets are present or nearby. Use the sheet metal belt and pulley cover to prevent fingers, clothing, etc., from getting caught in the moving belt. Do not leave out or bypass the fuse in building the Homemade DC Generator. If you won't be charging at above 30 amps, the 60-amp fuse can be replaced by a 30-amp unit, thereby providing better (quicker-responding) overload protection.

Do not use smaller sizes of wire than those mentioned and only use insulated wires. Bare wires if crossed could short-circuit and get red hot. If charging batteries that are located in a house, do not operate the charger within that structure. Instead build a separate, simple fireproof shed for the charger 20–60 feet from the house and run long, heavy-gauge, insulated wires from the charger to the batteries. In such cases, the fuse should be mounted in or on the house, quite near the batteries. However, if you prefer a portable unit, with the fuse mounted right on the charger, you can always take the batteries outside the house to charge them with the portable unit.

Cost Considerations. In building the Homemade DC Generator, the most costly items were: the engine, \$65.00; ammeter, \$17.76; booster cables, \$6.99; metal brackets and control panel, \$5.00; fanbelt, \$4.15; pine plank, \$3.61. In addition to the above, I spent another \$37.01 for wires, terminals, bulbs, bolts and nuts, pulleys, tumbuckle, etc. The total for the entire project came to \$137.52.

I'm quite satisfied with the way the charger turned out. And even with just one bulb in the circuit, my charger turns out between 20–25 amps, which can always be increased if desired. If the engine wears out, simply find another cheap used one; ditto with the alternator. Try *that* with a factory-built generator. Yes, I'm pleased with my new "toy," but it's a practical "toy"—one that I intend to put to good use for many years to come. ■



The Audio Q Multiplier

*Build our audio filter and hear
Morse code as clear as spring water!*

BY LARRY LISLE, K9KZT

How would you like an audio filter for Morse-code reception that's simple to build, uses easy-to-get parts, and yet can be tuned across the audio spectrum and adjusted from wide open to razor-sharp selectivity with the twist of a knob! If it sounds like something you could use, then read on.

Recently, I stumbled onto the idea of combining two old-time circuits, the Q-multiplier and the Wein-bridge oscillator, to make a very effective but simple audio filter. The Q-multiplier was a gadget a ham operator would use years ago to improve the selectivity of a receiver's IF stages through the use of controlled feedback. I found the same thing could be done with a Wein-bridge audio oscillator—a case of old Wein, new bottles!

How it Works. The circuit for the *Audio Q-Multiplier* is shown in Fig. 1. Since the filter is designed to be used

PARTS LIST FOR THE AUDIO Q-MULTIPLIER

RESISTORS

(All fixed resistors are 1/4-watt, 5% units.)

- R1—Dual 100,000-ohm potentiometer (Radio Shack 271-1732 or equivalent)
- R2—100,000-ohm potentiometer
- R3—15,000-ohm
- R4—2200-ohm
- R5—100,000-ohm

ADDITIONAL PARTS AND MATERIALS

- U1—741 op-amp, integrated circuit
- B1, B2—9-volt transistor-radio battery
- C1, C2—0.0056- μ F, 15-WVDC polystyrene capacitor
- S1—Double-pole, single-throw switch
- T1, T2—1,000-ohm to 8-ohm transformer
- Fahnstock clips, flat-head screws, small PC board, knobs, brackets for controls, socket for IC, wire, solder, wooden board, etc.

with any receiver having a low-impedance output, an audio-output trans-

former (T1) is connected backwards to step up the impedance.

The signal is then applied across the frequency-selective network consisting of R1, C1, and C2 that acts according to the formula:

$$f = 1/(2\pi RC)$$

At this point the selectivity, or "Q" isn't very good, but the signal now goes to the noninverting (+) input of op-amp U1, where it's amplified and a portion sent back to the input through the voltage divider made of R4 and R5.

As the gain of the op-amp is increased by adjusting R2, the selectivity of the circuit gets better and better because only a signal of exactly the right frequency can be transmitted completely around the loop without a change in phase. All others are attenuated. If the feedback is set too high, the circuit will oscillate, but normally it's held well below that point.

(Continued on page 110)

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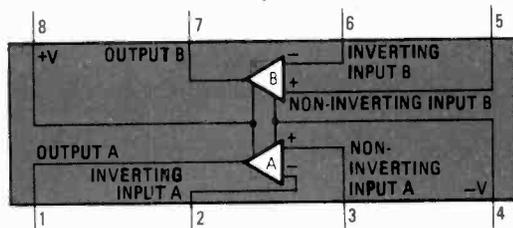
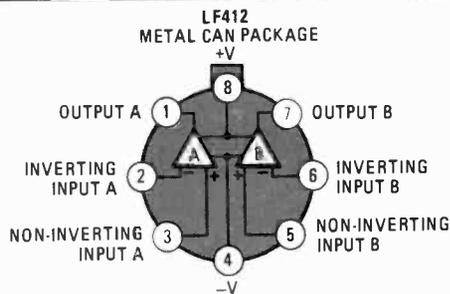
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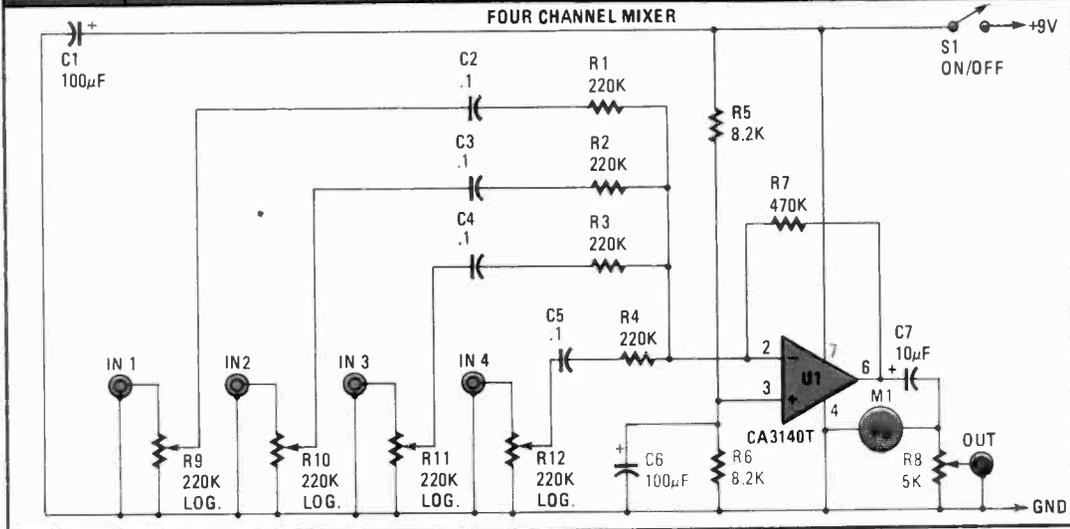
106 Popular Electronics FactCard LF412: Low Offset, Low Drift Dual JFET Op-Amp



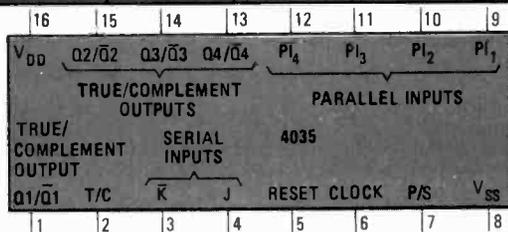
ABSOLUTE MAXIMUM RATINGS

	LF412A	LF412
Supply Voltage	±22V	±18V
Differential Input Voltage	±38V	±30V
Input Voltage Range	±19V	±15V
Output Short Circuit Duration	Continuous	Continuous
H Package		
Power Dissipation	670 mW	500 mW
T _j max	150°C	115°C
θ _{JA} Operating	150°C/W	160°C/W
N Package		
Power Dissipation	670 mW	500 mW
T _j max	150°C	115°C
θ _{JA} Operating	150°C/W	160°C/W
Storage Temperature Range	-65°C ≤ T _A ≤ 150°C	-65°C ≤ T _A ≤ 150°C
Lead Temperature (Soldering, 10 seconds)	300°C	300°C

107 Popular Electronics FactCard Four Channel Mixer



108 Popular Electronics FactCard 4035: 4-Bit Parallel-In/Out Shift Register



FEATURES

- Wide supply voltage range 3.0V to 15V
- High noise immunity 0.45 V_{DD} (typ.)
- Low power TTL compatibility fan out of 2 driving 74L or 1 driving 74LS
- 4-stage clocked operation
- Synchronous parallel entry on all 4 stages
- JK inputs on first stage
- Asynchronous true/complement control on all outputs
- Reset Control
- Static flip-flop operation; master/slave configuration
- Buffered outputs
- Low power dissipation 5 μW (typ.) (ceramic)
- High speed to 5 MHz

APPLICATIONS

- Automotive
- Data terminals
- Instrumentation
- Medical electronics
- Alarm systems
- Industrial controls
- Remote metering
- Computers

ABSOLUTE MAXIMUM RATINGS

V _{DD} dc Supply Voltage	-0.5 to +18V
V _{IN} Input Voltage	-0.5 to V _{DD} + 0.5V
T _S Storage Temperature Range	-65°C to +150°C
P _D Package Dissipation	500 mW
T _L Lead Temperature (Soldering, 10 seconds)	260°C

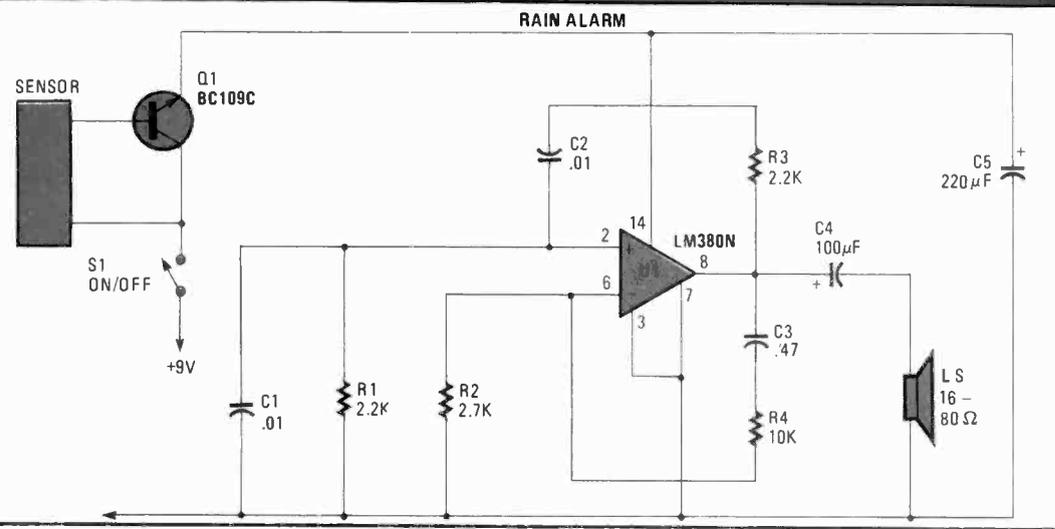
OPERATING CONDITIONS

V _{DD} dc Supply Voltage	3 to 15V
V _{IN} Input Voltage	0 to V _{DD} V
T _A Operating Temperature Range	-55°C to +125°C
CD4035BM	-40°C to +85°C
CD4035BC	

DC ELECTRICAL CHARACTERISTICS

Parameter	Conditions	LF412A	LF412	Units
		Typ	Typ	
Input Offset Voltage	$R_S = 10\text{ k}\Omega$ $T_A = 25^\circ\text{C}$	0.5	1.0	mV
Average TC of Input Offset Voltage	$R_S = 10\text{ k}\Omega$	7	7	$\mu\text{V}/^\circ\text{C}$
Input Offset Current	$V_S = \pm 15\text{V}$ $T_I = 25^\circ\text{C}$	25	25	μA
	$T_I = 70^\circ\text{C}$			nA
	$T_I = 125^\circ\text{C}$			nA
Input Bias Current	$V_S = \pm 15\text{V}$ $T_I = 25^\circ\text{C}$	50	50	μA
	$T_I = 70^\circ\text{C}$			nA
	$T_I = 125^\circ\text{C}$			nA
Input Resistance	$T_I = 25^\circ\text{C}$	10^{12}	10^{12}	Ω

Parameter	Conditions	LF412A	LF412	Units
		Typ	Typ	
Large Signal Voltage Gain	$V_S = \pm 15\text{V}$, $V_O = \pm 10\text{V}$, $R_L = 2\text{k}$, $T_A = 25^\circ\text{C}$	200	200	V/mV
	Over Temperature	200	200	V/mV
Output Voltage Swing	$V_S = \pm 15\text{V}$, $R_L = 10\text{k}$	± 13.5	± 13.5	V
Input Common-Mode Voltage Range		+19.5	± 14.5	V
		-16.5	-11.5	V
Common-Mode Rejection Ratio	$R_S \leq 10\text{k}$	100	100	dB
Supply Voltage Rejection Ratio		100	100	dB
Supply Current		3.6	3.6	mA



STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS			LIMIT at +25°C (TYP)	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Quiescent Device Current	—	0.5	5	0.04	μA
I_{DD} Max	—	0.10	10	0.04	
I_{DD} Min	—	0.15	15	0.04	
I_{DD} Max	—	0.20	20	0.08	
Output Low (Sink) Current	0.4	0.5	5	1	mA
	0.5	0.10	10	2.6	
	1.5	0.15	15	6.8	
Output High (Source) Current	4.6	0.5	5	1	mA
	2.5	0.5	5	-3.2	
Current	9.5	0.10	10	-2.6	mA
	13.5	0.15	15	-6.8	

CHARACTERISTIC	CONDITIONS			LIMIT at +25°C (TYP)	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Output Voltage Low-Level	—	0.5	5	0	V
	—	0.10	10	0	
	—	0.15	15	0	
Output Voltage High-Level	—	0.5	5	5	V
	—	0.10	10	10	
	—	0.15	15	15	
Input Voltage	0.5, 4.5	—	5	—	V
	1.9	—	10	—	
	1.5, 13.5	—	15	—	
Input Current	—	0.18	18	$\pm 10^{-5}$	μA
	—	—	—	—	
	—	—	—	—	

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VOLUME 2
NUMBER 5

A CHRONICLE OF CONSUMER ELECTRONICS

PC Perfection

PGS ULTRASync MONITOR. Manufactured by: Princeton Graphics Systems, 601 Ewing St., Building A, Princeton, NJ 08540. Price: \$849.

Princeton Graphics Systems has specialized in producing top-shelf computer displays for IBM-compatible microcomputers since Big Blue first introduced the IBM PC. The top of the company's computer-monitor line is the *PGS UltraSync*. The UltraSync is an example of the hottest monitor type in the world of microcomputers; the multiscanning monitor. Those units can take advantage of the analog IBM VGA (video graphics array) graphics-adaptor standard, the CGA (color-graphics adapter) standard, as well as TTL (transistor/transistor logic) digital signals.

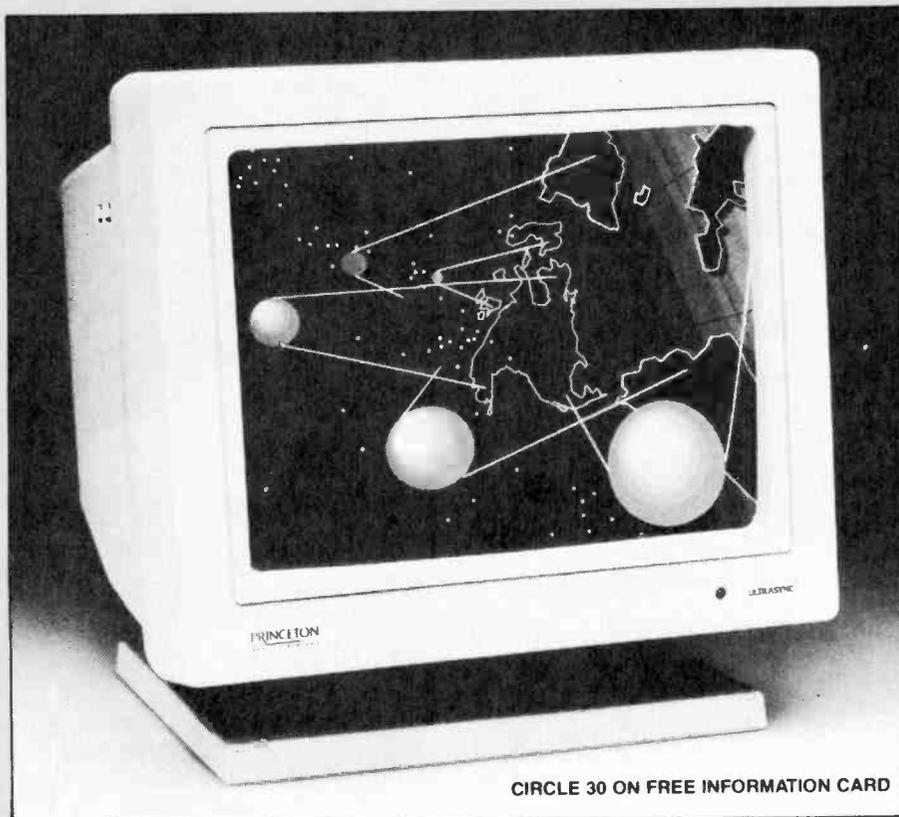
The VGA adapter takes direct control of a monitor's primary-color guns, the red, green, and blue (RGB). It uses rising signal voltages, a system that results in directly proportionate increases in brightness. As a result, a monitor with VGA capability can display up to 256 colors (out of a dazzling potential palette of 262,144 colors).

Multiscanning monitors can operate in at least 17 different video modes and, because the UltraSync supports horizontal-scan rates as high as 35 kHz, it is likely to work with the advanced graphics adapters of the future.

In the case of the UltraSync, good things undoubtedly come in small packages. UltraSync's display-cabinet dimensions are 12.4- by 12.3- by 14.2-inches. The compact case sits atop a sturdy, smooth-working tilt/swivel base.

UltraSync is equipped with both RGB and analog inputs, using either DB-25 or 15-pin cable connectors. The cable provided with the UltraSync is a generous 73-inches long and is fully detachable for an added measure of flexibility.

The UltraSync, as a multiscanning monitor, adjusts to a wide variety of display cards. The monitor automatically recognizes synchronizing signals from CGA (color graphic adapter), MDA (mono-



CIRCLE 30 ON FREE INFORMATION CARD

chrome display adapter), EGA (enhanced graphics adapter), VGA, and HGA (Hercules graphic adapters) standards, and adjusts accordingly. In addition to all those IBM-compatible graphics standards, the UltraSync is fully compatible with the Apple Macintosh II.

UltraSync's control system provides for almost any conceivable adjustment or video mode. The power switch and the text-mode switches are positioned on the right-hand side of the cabinet. The brightness and contrast controls are on the left-hand side. The controls for vertical and horizontal position, and for horizontal and vertical sizing, are located on the back of the monitor cabinet, as is the control for selecting analog or TTL mode.

The UltraSync has a complete series of settings for its elegant text-mode images. The text-mode button is very accessible, which makes it easy to cycle through the excellent variety of crisp, monochrome

text modes.

The first is an extraordinarily pure white. Another press of the text-mode button and the user is presented with regular monochrome green; then a smooth, true amber; and finally a cool cyan (blue) appears. All of those text-mode, monochrome colors are displayed on a pleasingly deep, black background.

The real gravy on all of this terrific technical gadgetry is UltraSync's picture. The display images are as sharp as a paper cut and as bright as can be imagined. The rapier sharpness of this monitor is a direct result of its maximum resolution of 770 × 570 pixels.

In testing the UltraSync's luminosity GIZMO's tester turned up the brightness level to its maximum. The result bordered on the painful. UltraSync, sporting a 0.28mm dot pitch (an industry-wide pace setter), maintained a crisp, clear resolution

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CIRCLE 31 ON FREE INFORMATION CARD

Miniature Marvel

AM(LW/MW/SW)/FM STEREO DIRECT-ACCESS WORLD-BAND RADIO KIT (ICF-SW1S). Manufactured by: Sony Corp. of America, Sony Drive, Park Ridge, NJ 07656. Price: \$399.95

For anyone on the go who seeks a light-weight, miniature all-band clock/radio, it's difficult to imagine a more ideal unit than the *Sony ICF-SW1S*. This, the most diminutive of Sony's *World Band Radios*, comes with an active antenna, headphones, a multi-voltage A/C adapter, and a shortwave listening guide—all packed into a 9- by 11-inch carrying case.

The radio itself is an ultra-compact, 8-ounce marvel that's only a little larger than a cigarette pack, yet boasts AM, FM, and FM-stereo; 14 shortwave bands; digital tuning; scanning; ten-station memory; an alarm clock; and sleep functions. Remarkably, the sound and performance of this miniature receiver matches that of conventionally sized radios.

Finished in charcoal gray and matte black, the radio features a direct-entry tuning keypad (resembling a telephone-style keypad) with manual tuning switches occupying the right half of the unit, just

beneath an easily readable 2- by ½-inch liquid-crystal display. With the radio on, the LCD shows the tuned frequency. With the power off, it displays the time and status of the alarm and sleep features. The radio's design is practical, and all functions are clearly labeled.

One nice touch is the telescoping 20-inch antenna, which folds completely inside the radio, protecting it against possible damage in transit. An antenna that short would normally be barely adequate for good FM reception. Yet, when we tested it in Manhattan, the ICF-SW1S effortlessly pulled in the BBC and Radio Denmark (among dozens of overseas broadcasts). With the supplied 40-inch telescoping external antenna attached, reception was flawless.

Coverage extends from 150 kHz (just below the AM dial) to 29.995 MHz, across 14 pre-defined bands—11, 13, 16, 19, 21, and 25 meters—with additional coverage in the 31, 41, 49, 60, 75, 90, and 120 meter bands. In short, this tiny Sony will pick up just about any shortwave transmission.

The included guide book (entitled *The Wave*) contains a wealth of information pertaining to international shortwave broadcasting. Dozens of stations, times of transmission, frequencies, and types of broadcast are listed in a well-arranged, easily accessible fashion.

The ICF-SW15 is an excellent AM/FM radio for normal everyday domestic use; its 10 memories can be used to store favorite AM/FM/shortwave stations, placing them just a fingertip away. The FM sound is surprisingly rich—crystal clear, considering the size of the speaker (about 3- by 1-inches)—but don't expect a lot of bass from a unit this size. A filter setting on the side of the radio shapes the sound for "news" or "music." In the "news" position, treble is cut back somewhat to reduce the hiss that is typical of shortwave speech transmission. Adjusting alarm and clock times is as simple as pressing the "alarm set" or "time set" buttons and simultaneously pressing the tuning button until the desired time appears.

Sony says the radio will operate for

about 12 hours on two "AA" alkaline batteries. But we clocked it at closer to 16 hours.

The ICF-SW15 comes equipped with a number of useful accessories, including a universal power supply that automatically adjusts itself to 110 or 220 volts, and features an adapter plug that fits most European outlets. Also included is the aforementioned 40-inch telescopic antenna (AN-101), which features a built-in amplifier for greater signal-pulling power.

The antenna module is an important accessory, as it vastly improves the already excellent reception. Four "AA" cells power the antenna, which is intended to be propped in a window and swiveled to the best reception position. A small suction cup holds the antenna in place, and a 12-

foot cord easily stretches from the antenna to, for example, a bedside table. A cable of that length could be a nuisance to fold up, but Sony's practical design includes a winder that retracts it into the antenna base.

Traveling with the ICF-SW15, we began to appreciate its small size as much as its quality, especially when luggage space was at a premium. We've used this radio to monitor our favorite shortwave broadcasts from hotels across the country, in Mexico, and in Canada. It performed the task beautifully—and never failed to get us up when the hotel wake-up calls didn't come through. At its suggested retail price (or even at discount prices) this radio might not fit everyone's budget. But if miniature is a must, then so is the ICF-SW15. ■

Station to Station

REALISTIC SELECTACOM THREE-CHANNEL WIRELESS FM INTERCOM. Manufactured by: Radio Shack Division, Tandy Corp., One Tandy Center, Fort Worth, TX 76102. Price: \$99.95.

What attracted us to the *Realistic Selectacom* three-channel, wireless, FM intercom was its sheer simplicity. (In our home, there are family members for whom any electronic feature beyond "on/off" creates a state of high anxiety.) We were in dire need of some kind of intercom. Too much time was being wasted walking up and down stairs to get answers to simple questions. After looking at a number of intercom models and brands, we settled on the Selectacom when the sales person gave us this succinct summary of its installation: "Just plug it in." Once purchased, it took us 30 seconds to explain the workings of the Selectacom system to those who would be using it (including a five-year-old)—a big plus for the non-technologically inclined.

The Selectacom works by sending an FM signal through the house's (or office's) electrical wiring. The system comes with three stations and provides drastically reduced line noise and interference because it uses frequency-modulation. In use, there was no buzz, as is sometimes heard on such communication devices: the unit is blessedly silent until a call tone or message is received.

Each station is a little bigger than a thick paperback book, and not much heavier (15 ounces). No batteries are necessary, as the Selectacom system draws its power from the outlet to which each station is connected.

To talk to somebody at another station, the user first presses the "call" button. That produces a short signal beep. Then

the user presses the station "talk" bar and begins speaking. The talk bar can be locked on for hands-free operation.

To receive, the user has to disengage the talk bar. The station cannot receive a message while locked into the talk position.

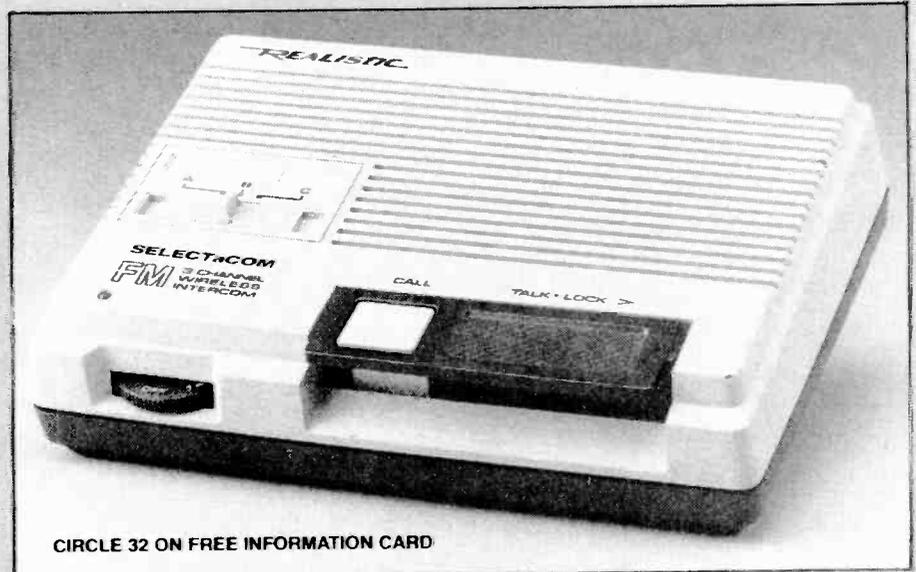
A feature not mentioned in the instruction booklet is the system's eavesdropping potential. When nobody is around, a user so inclined could just leave the talk bar in the locked position and listen in from another station. One use for that would be to monitor a youngster's bedroom or play area.

The signal-to-noise ratio is given as 40 dB at 20 mV. Each station can operate on one of three separate channels—at 160 kHz, 200 kHz, and 230 kHz. That means you can have three separate communications networks.

We have the home office on channel A, the kitchen on channel B, and a basement workshop on channel C. The office can talk to the kitchen by setting its selector to B, or to the workshop by setting the selector to C. If A calls B, it will not be heard on C. Additional intercom units can be pur-

chased and added to the original trio of stations, although further stations will only be able to operate on the same three channels. For conference-style calls, the originating station instructs all parties to switch to the same channel. Everyone can then hear the message, although only one participant can talk at a time. If two stations attempt to talk at the same time on the same channel, the result is likely to be a loud electronic squeal.

The stations can be installed anywhere, as long as they're connected to the same power line (or, as the instructions express it, the same "power-distribution transformer"). The stations can be separated from each other by distances of up to 300 feet. Each unit has a squelch control in case there's a hissing sound when listening. The squelch control is factory set for maximum performance. If, however, a bothersome hissing is heard, the control can be adjusted through an access hole in the bottom of each station. The units can be wall-mounted, although we like the portability of being able to plug them into any available electrical outlet. ■



CIRCLE 32 ON FREE INFORMATION CARD



CIRCLE 33 ON FREE INFORMATION CARD

Synthesizer A-Go-Go

BREAKAWAY MUSIC SYSTEM VOCALIZER 1000. Available from: The Sharper Image, 650 Davis Street, San Francisco, CA 94111. Price: \$299.

Many music fans have fantasized at one time or another about standing on stage, microphone in hand, and running through a few tunes to the cheers of an adoring crowd. With *Breakaway Music Systems' Vocalizer 1000*, an approximation of that fantasy can be achieved—although the user will probably never produce a Top-40 hit on the synthesizer-like recording device. In terms of technology, the Vocalizer 1000 is an introduction to the digital synthesizers and sampling devices that have revolutionized the production of music in the past decade.

The Vocalizer 1000 works like a standard synthesizer, but instead of hitting a keyboard, the human voice is the keystroke that activates an array of instrument-like sounds. The sounds can be recorded and monitored, or rerecorded for a layered sound. Once the device is mastered, the Vocalizer 1000 and its user can sound quite professional.

Aside from the novelty factor, the advantage of using the voice instead of a keyboard is that the amateur music maker doesn't need to learn keyboard technique to make music. The user doesn't even need a sense of pitch, although it helps to be able to carry a tune. According to the device's instruction manual, "The Vo-

Photo © The Sharper Image

calizer's patented voice guide technology helps you stay in tune." However, that feature works only in conjunction with the "SmartSong" cartridges described below. Built-in demonstration sequences (activated with the "demo" button) clarify various aspects of the device's capabilities and functions, guiding the novice. The Vocalizer's LCD also guides use, confirming selected options and indicating steps and programming choices—much like a VCR's "on-screen programming" or a computer program's instructional cues.

Using the Vocalizer 1000's 28-instrument selection keypad, an instrument is chosen: the clarinet, for example. The user then hums into the handset microphone from about an inch away at a normal-speaking volume level and the synthesizer converts the hum into a sound like a clarinet. To keep the humming private, a personal mouthpiece can be used.

A total of 28 instrumental sounds are programmed into the system, with "dozens more available through add-on instrument sound cartridges." Those can be further enhanced with standard synthesizer stereo effects like echo, harmony, slide, octave switches, and varying volume levels.

The Vocalizer 1000 also features a series of what the manufacturer, *Breakaway Technologies, Inc.*, calls "SmartSongs"—50 programmed patterns that provide background accompaniment in rock, country, Latin, soul, blues, and reggae styles. With the unit's digital recorder, and using the editing and overdubbing capabilities of the device, a complete composition can be produced.

But all that is instrumental effect, making the name of the system a bit of a

misnomer. The only way to add a vocal track to a Vocalizer composition is by connecting an audio-cassette recorder to the device with an "audio-out" cable (included with the Vocalizer) plugged into the deck's line or microphone input. The user then sings into the tape-deck microphone, along with the Vocalizer's already recorded instrumental tracks.

Although a mostly-for-fun device, the Vocalizer 1000 is anything but unsophisticated. The unit incorporates MIDI (musical instrument digital interface) technology that allows it to be connected to another synthesizer, or to another Vocalizer. Further, the Vocalizer can be controlled by external MIDI-equipped devices. The system itself features a multi-track digital recorder (MDR) capability. Its cassette bay takes not only the "SmartSong" and additional instrumental-sound cartridges, but blank cassettes (for recording) as well.

In our brief session with the Vocalizer 1000, we ran into a few problems; most of them were anticipated by the well-written and -organized instruction manual. It took some practice to find the right timing. Sustaining the voice and changing the tone, as suggested by the manual's "tips on vocalizing," had a much better effect than heeding the more natural tendency to stop and start.

Another problem is one that musicians have long been familiar with—it is hard to hear what is being produced at the time of production. The built-in 3½-inch speaker gave sufficient sound, but it was confusing to hear the notes as we were humming them; the tendency was to stop to listen, forgetting to make new notes. There is also a slight delay between the vocal input and the instrument sound being generated. Vocalizing at a higher pitch minimizes that delay.

The Vocalizer that we used wasn't long on clarity; all the synthetic instruments sounded similar. Even with the unit's 28 programmed options, it was hard to tell which instrumental sound was being produced. The instruction manual indirectly alludes to this, suggesting, "for the best sound quality, plug the Vocalizer into your home or portable stereo."

The Vocalizer 1000 draws power from six "C" batteries or an included AC adapter. The ten-note polyphonic and polytimbral synthesizer samples in stereo over a 7-octave range and can be tuned up or down a quarter tone.

The instruction manual is a helpful guide to the myriad options, but the best way to learn the Vocalizer is probably through trial and error. Like full-size synthesizers, the Vocalizer 1000 is more easily demonstrated than described. The Vocalizer may not launch many musical careers (then again, we wouldn't bet on that), but for someone looking to have some fun with music, the Vocalizer is an easy-to-play instrument in itself. ■

VCR Vision

TOSHIBA VIDEO CASSETTE RECORDER (M-6275). Manufactured by: Toshiba America, Inc., 82 Totowa Road, Wayne, NJ 07470. Price: \$450.

Video-cassette recorders have become a staple of home entertainment in a surprisingly short time. Interestingly enough, the time frame corresponds pretty closely to the period in which it took the television to move from an esoteric luxury item to America's favorite home appliance. It's also interesting to note that the VCR was an established fact of electronic life in British and French households some time before the device fully penetrated the U.S. consumer market. That is due largely to the fact that U.S. broadcast TV is more varied than European television (or at least it was in the early years of home video). With fewer viewing options available, home taping enabled Europeans to view favorite programs at a time of day most convenient to them.

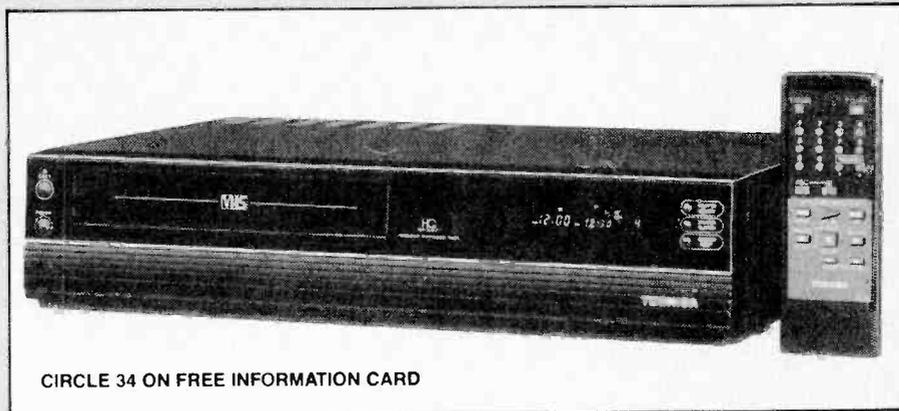
VCR's, of course, sparked an entire new service industry—video cassette rental—but the devices' most basic use is still as an adjunct to broadcast television. With a VCR, TV is removed from its relentless real-time broadcast mode and made to conform to the viewer's personal schedule requirements. VCR owners can reshape entertainment time in their own homes. Since TV works as mass media on its most gargantuan scale, when enough of the population owns VCR's, it has an impact on the TV industry itself.

That impact can be seen in both the TV and advertising industries' concern over the audience's ability to bypass commercial messages (with the VCR's "fast forward" control) and in the shrinking network-TV audience, as recorded by rating surveys. The home-video revolution, in tandem with the growth of cable operations and viewership, is reshaping the television industry on a scale and at a rate that few could have predicted some years back.

When a nation of TV viewers can stop time as they please, develop their own programming packages, and even ignore electronic mass media entirely, then the video-cassette recorder has clearly arrived. The VCR takes decision-making out of the control of programmers and advertisers and places it directly into the remote-controlling hands of the viewers themselves.

For that to happen, of course, VCR's must be inexpensive enough to fit the average TV fan's budget, and over the years that's exactly what's happened. It's possible to find an extremely capable machine for under \$500—and we're not referring to those retread models being pitched on the various home-shopping channels.

Case in point: A major electronics retail chain advertised the *Toshiba M-6275* for a



CIRCLE 34 ON FREE INFORMATION CARD

price hundreds of dollars less than the manufacturer's suggested retail price. Armed with the newspaper ad, we went to the store determined to take advantage of this bargain, only to be told the model was temporarily out of stock. Since this was on the first day of the sale, we recognized the ploy that's sometimes called "bait and switch." Get the consumer into the store by advertising an extraordinary value, then switch his or her attention to a less-discounted unit. We insisted that the store live up to its newspaper advertisement offer. The salesperson claimed that there were none left, except for the display model. "Fine," we said, "we'll take it."

After having lived with the M-6275 for a few months, we're glad that we were feisty enough to demand the advertised special. Although this is the lowest priced of Toshiba's current line of VCR's, it is a solid machine, loaded with the features that a few years back were available only on top-of-the-line models. In our experience, this particular VCR is a splendid piece of electronics that performs as well as many higher-priced machines.

We particularly appreciate its ease of operation. As soon as any cassette is inserted into the front-loading HQ machine, the power goes on automatically. When a pre-recorded tape is loaded, the power goes on, then the cassette is automatically played and rewound. After the tape finishes rewinding, the machine shuts off automatically—especially useful for those viewers with a tendency to doze off during home-video presentations.

The unit's two-way picture-search function allows the user to speed up or play back both forward or in reverse at 5 times or 15 times the normal playback speed. Still-frame and slow-motion functions also perform at a level surprising in a lower-priced VCR.

A "one-touch" control makes it easy to record manually, and there's a 14-day, 4-program timer for unattended recording. In contrast to some other brands on the market, this unit's remote control can't be used to activate or set the programmable timer. A channel-preset function allows the storage of up to 16 channels and the remote's channel-select buttons will auto-

matically bring up any of those presets. Slow tracking via the remote is possible only if the machine is set on the extended-play mode. The unit's 20-function remote controller will work at a distance of not over 23 feet from the VCR and it must be within an angle range of 30 degrees from the machine's infrared receptor (located in the center of the VCR's front panel, between the LCD display and the cassette compartment). In our use, the remote provides plenty of control, powered by the usual two "AA" batteries.

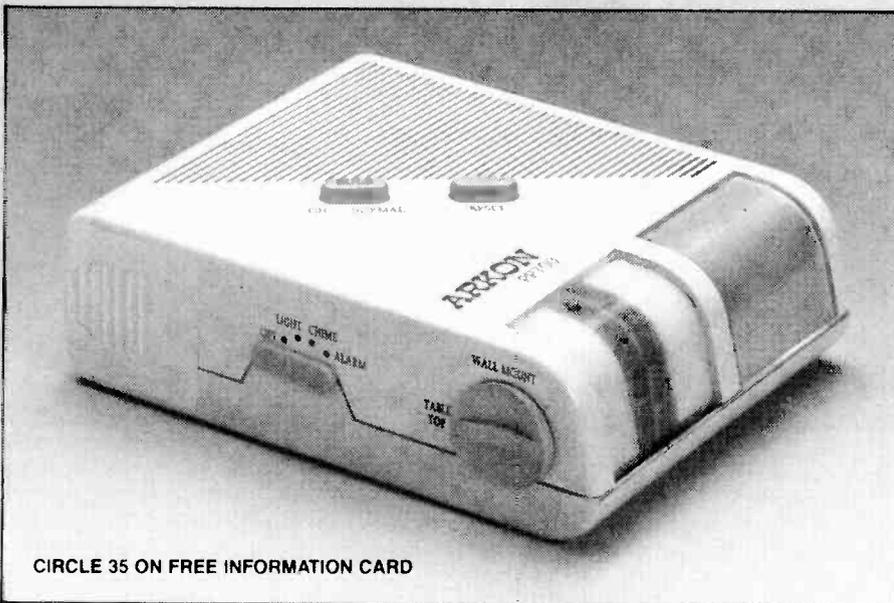
The controls hidden behind the VCR's front-panel door (beneath the LCD) include both tracking-adjustment and picture-sharpness controls; the latter is a refinement we had not seen on earlier VCR's. It is operational during both recording and playback.

Another update is the unit's "voltage synthesizer" (VS) PLL tuner. Not so many years ago, tuning a VCR was a laborious process of individual fine-tuning adjustments for each UHF and VHF channel. The M-6275's VS tuner "automatically locates and tunes channels." All the user does is press the tuning buttons.

The unit's counter functions also offer a couple of useful refinements. The "counter memory button," according to the manual, "programs the beginning of a certain program into the VCR's memory so that the tape begins playing at the designated location automatically when rewound or fast-forwarded." The usual counter display, with the press of a button, will indicate time elapsed on the cassette.

According to Toshiba, the M-6275 is "122-channel cable compatible." Our cable service offers roughly half that number of channels, so we haven't pushed the unit's cable compatibility to the limit.

As both a recording and a playback machine, the M-6275 has worked just the way we wanted it to—consistently, flawlessly, and automatically. At this stage in VCR use, those once miraculous machines are like televisions in that most consumers want merely to plug them in, turn them on, and then never have to think about them again. In that regard, the M-6275 is both silent and invisible—and that's definitely what the VCR revolution is about. ■



CIRCLE 35 ON FREE INFORMATION CARD

Travel Alarm

ARKON PORTA-GUARD PORTABLE MOTION ALARM (PP-700). Manufactured by: Arkon, 11627 Clark St., Suite 101, Arcadia, CA 91006. Price: \$59.95.

Watching the local news any evening, or reading the front page any morning, is enough to make anyone security-conscious. Some might even use the word "paranoid." While elaborate security systems and devices are a fast-growing category of electronic products, some manufacturers are also trying to make such items available in lower price ranges. One hardly has to be wealthy to fear intruders or crimes against property.

The *Arkon Porta-Guard Portable Motion Alarm* is one example of a product that tries to assuage some of those fears at a reasonable price. At eight ounces, and just a little bigger than 4 by 5 inches, this compact motion alarm could easily fit into a suitcase or even a briefcase. For travelers, it can afford some peace of mind, or at least a warning if an intruder enters the user's hotel room. Needless to say, the Porta-Guard can provide the same warning protection at home.

Before describing how the Porta-Guard operates, let's point out what this device is not. It is not an alarm unit that will beep so loudly that neighbors will notice it; nor will it attract the attention of police cruising by.

What it will do is give notice that somebody just entered the area it covers. As a matter of fact, another use for the Porta-Guard is as a chimer to let a store owner know when a customer has come in. Or it can be used to keep track of youngsters running in and out of the house.

The Porta-Guard works by using a "pyroelectric sensor," which (we believe)

is an infrared beam-style detector. It has a 30° horizontal and 15° vertical field of coverage, which translates to a detection area measuring approximately 8 by 15 feet. Those dimensions are interchangeable, depending on whether the unit is placed flat or on its side. If desired, the device can be wall-mounted. If installed on a wall, the device's sensor-angle selector is set accordingly, orienting the field of coverage horizontally. If placed flat, the selector should be set to "table top."

The Porta-Guard operates on one 9-volt and two "AA" batteries, although it can also be powered by a 12-volt AC/DC adapter (not supplied with the unit). The Porta-Guard produces three types of warnings if it detects motion—a light, a chime, or an alarm. The light, a 2.5-volt, 300-mA screw-in type, is small, but very bright. The alarm is a piercing, insistent beep.

The detection area is basically cone shaped, with the widest area of coverage the farthest away from the unit. The alarm should be placed so that an intruder would cross the front of the detection area, instead of walking toward or into it. Also, the unit does not seem to operate at peak-coverage efficiency if there are large objects—such as a sofa or other furniture—in the detection area, because they block the infrared beam.

To activate the unit, the user sets the mode selector to "light," "chime," or "alarm." Then the user waits for 30 seconds before walking in front of the Porta-Guard to trigger it and to check that the alarm or chime is properly set. When testing the light, the user has to darken the room or cover the light sensor on the unit with black paper. The chime sounds for five seconds, the alarm for 30 seconds; the light stays on for a full minute.

In a hotel or home bedroom, the light option, besides its security function, is supposed to give the user automatic illumination when getting up at night.

There's also a switch that enables the unit's light to be used as a flashlight.

We found that the Porta-Guard does indeed swiftly detect motion. It was so good at its function that it alerted us to the movement of our two cats as they ambled past it at night. After a few such late-night false alarms, we decided that the best use for the unit was in a hotel room.

We also used the unit in conjunction with a household intercom system to provide some security in a workroom separated from the main living area of our home. Worried about break-ins, we set the intercom on the talk position, and then placed the Porta-Guard in the workroom, near the entrance. The intercom would immediately pick up the device's alarm.

We have taken the Porta-Guard with us on a few out-of-town trips, using it in motel and hotel rooms. We are glad to report that we haven't had to find out if it works in a real-life emergency situation, although its psychological effect when sleeping in a strange room is not to be discounted.

Electronic-security gizmos are great as far as they go. But what the Porta-Guard's instruction manual doesn't explain is what to do when the alarm sounds and you're face-to-face with that intruder. There remain some situations that no amount of technology can cope with. ■

PC PERFECTION

(Continued from page 1)

on all characters even at that very intense brightness level.

There was no fringing of colors—the presence of extraneous colors—around characters or along the long edges between color areas. Linear distortion was non-existent. The colors generated are vibrant and very true, especially white.

It seemed amazing that the UltraSync's image was always perfectly centered within a constant 1/8-inch border. Unwavering exactitude of that nature speaks well of the engineering that went into this product. Also indicative of quality engineering is the fact that UltraSync's automatic vertical-sizing features handled all video mode changes without a hitch.

The UltraSync is not perfect. We did note that as the brightness levels increased toward the painful state described above, a fair amount of blooming occurred; that is, an increase in image size as brightness levels increase (caused by an increase in deflection of electron beams tracing on a display screen). The image also noticeably softened in the display's corners.

All in all, however, GIZMO found that the UltraSync offers fine value at its price. Perfection isn't often possible, even in the rarefied field of contemporary computer technology. But as an approximation of that state, the UltraSync comes close enough to remind us of the elusive possibility. ■

For more information on any product in this section, circle the appropriate number on the Free Information Card.

ELECTRONICS WISH LIST

Telephone Outlet System

The explosion in cordless-telephone use is not without its drawbacks. The absence of problems with batteries, weak signals, noise, and other interference make the *Phonex System* from *Phonex Corp.* (P.O. Box D, Provo, UT 84603) a useful way to expand telephone access in household or office areas not covered by conventional phone outlets. The Phonex system consists of a small base unit and a remote extension unit that plugs into any electrical outlet and converts it to a phone jack to which any ordinary telephone can be connected. The company says Phonex "provides clear communication because the audio signals from the telephone and phone lines are converted to radio signals, which are transmitted between the units over regular AC wiring." Price: \$129.95.

CIRCLE 36 ON FREE INFORMATION CARD

Remote Control Relay System

With the accumulation of more and more electronic entertainment equipment, the sophisticated electronics consumer has been putting more components in cabinets to reduce visual clutter. With that solution comes the new problem of how to control all the gadgets inside the cabinets. One answer is the *Hidden Link Remote Control* by *Xantech/Videolink* (12950 Bradley Ave., Sylmar, CA 91342). The system utilizes the component's existing remote control, which is connected to a small hidden-link unit mounted on top of a cabinet. As the box receives the infrared signal from the remote control, it simply transfers the signal via normal speaker wire to a pair of infrared LED's inside the cabinet, which relay it to the component. The doors remain closed, keeping the system out of sight. The Hidden Link system is smaller than a cigarette pack and is easily installed. Price: \$49.95.

CIRCLE 37 ON FREE INFORMATION CARD

Portable Personal Copier

For the business person on the go, the *Transportable Personal Copier (Z-30)* by *Sharp Electronics Corp.* (Sharp Plaza, Mahwah, NJ 07430) has a handy carrying handle and weighs less than 25 pounds. The machine, Sharp says, "is designed for use by students, home office workers, and small businesses." It features automatic exposure, can make 4 copies per minute, and up to 9 continuous copies. Warm-up time is just 20 seconds and the user can stack up to 50 sheets at a time in the unit's stack paper feeder. Copies can be made to a maximum of 8½- by 11-inches to a minimum of 2- by 3½-inches. Price: \$4,799.

CIRCLE 38 ON FREE INFORMATION CARD

Video-Game Joystick

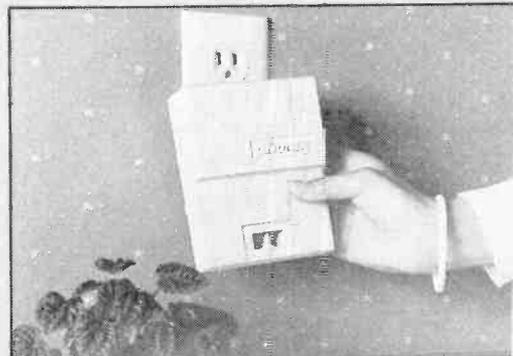
If your Atari and Commodore video games have been getting a workout lately it might be time to pick up a new joystick. *Happ Controls* (1251 Pagni Drive, Elk Grove, IL 60007) is offering the *Competition Pro Joystick (300X)*. It comes with a two-year warranty and features top and trigger-fire buttons along with dual base-fire buttons. The Competition Pro can also be used as a second joystick on game systems that allow dual control, so the game players can battle it out side by side. Price: \$9.95.

CIRCLE 39 ON FREE INFORMATION CARD

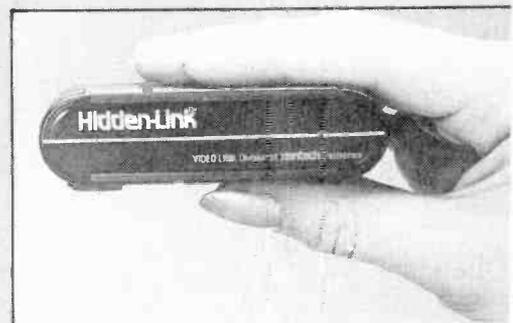
Sound Re-equalizer

You're planning a party and want to make tapes from old records. You have 78's, 45's, and even ancient broadcast transcriptions and you want it all to go through your contemporary stereo system without sounding like so much audio mush. Try the *Esoteric Sound Re-equalizer* from *Esoteric Sound* (4813 Wallbank Ave., Downers Grove, IL 60515). The company says that the unit compensates "for the many different recording curves of the mono era" and will clear up everything from old 78's to early dual-groove stereo discs. The company also says that it solves the problem of compensation for gross frequency distortion, while compensating for over-miking and excess noise. The unit comes with four pages of compensation settings to accommodate any vintage record. Price: \$225.

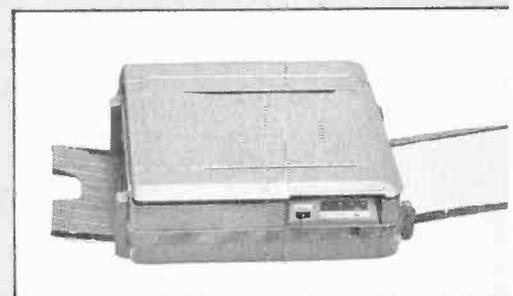
CIRCLE 40 ON FREE INFORMATION CARD



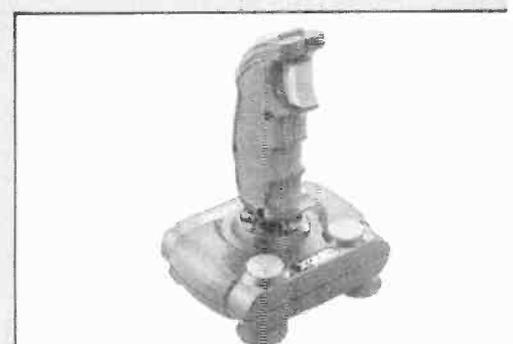
Phonex Telephone-Outlet System



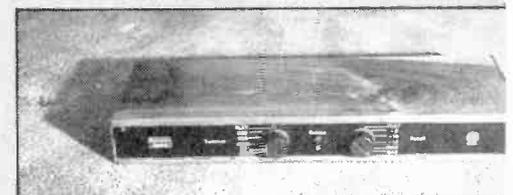
Videolink Remote Control Relay System



Sharp Portable Personal Copier



Happ Controls Video-Game Joystick



Esoteric Sound Re-equalizer

ELECTRONICS WISH LIST

For more information on any product in this section, circle the appropriate number on the Free Information Card.



Hitachi Automotive LCD Television

Automotive LCD Television

Two activities that rank among the favorite pastimes of Americans are driving cars and watching television. Now, a new product from *Hitachi Sales Corp. of America* (401 W. Artesia Blvd., Compton, CA) should make it possible to safely combine the two. The firm calls its 5-inch *Automotive Color LCD Television* the first of its kind. It uses a dual-antenna system and a diversity tuner to assure "perfect broadcast reception, even in a moving vehicle." The LCD screen has 115,200 pixel elements, providing 480 lines of horizontal resolution and 240 vertical lines. The tuner is able to switch between inputs up to 60 times per second. And don't worry about driving while the set is on. Hitachi has designed a special interlock that permits only audio while the car is in motion. In vehicles in which the screen is not visible to the driver (as in the back seat of a limousine), the interlock can be circumvented. In announcing the product, a spokesman for Hitachi pointed out, "the future applications of a 5-inch color TV in the car will likely be in the areas of navigation, instrumentation systems monitoring, and CD-V." Currently available in Japan, U.S. market introduction might come later this year. Price: To be announced.

CIRCLE 41 ON FREE INFORMATION CARD



Haverhills Electronic Scoreboard

Electronic Scoreboard

You'll know the score instantly and electronically with this handsome addition to the basement rec room or the backyard basketball court: the *Electronic Scoreboard*, available from *Haverhills* (131 Townsend St., San Francisco, CA 94107). This home scoreboard looks like the real thing, with a big LCD display for the score. Entries are made at the push of a button and a buzzer acknowledges the inputs. It plugs into any AC socket and comes with wall mounts. Any game with two teams can be scored. The totals will be easy to read on this 14-inch high by 22-inch wide by 3-inch deep electronic scoreboard. Price: \$199.95.

CIRCLE 42 ON FREE INFORMATION CARD



Nissei Five-in-One Fax Machine

Five-in-One Fax Machine

Home-office work often demands a variety of tasks in a limited work space. The *Five-in-One Facsimile Machine* from *Nissei Electric USA* (3 Reuten Drive, Closter, NJ 07624) helps save space by combining numerous functions in one multi-purpose unit. It's a fax machine, a scanner, a printer, a photocopier, and a modem—all in one. The machine connects to a personal computer through the RS232C port, and is compatible with IBM XT/AT's and CCITT Group 3 facsimiles. The user can send ASCII files directly from the PC, or from hard copy fed into the Five-in-One for transmission. It can send the same message to several locations in sequence, can scan and store, can preset the fax to be used during low telephone-rate periods, and can trace all fax activity. The machine offers fax-to-fax, computer-to-fax, fax-to-computer, and computer-to-computer communications. It uses Paintbrush and WordStar programs and others are being tested. Price: \$2,999.

CIRCLE 43 ON FREE INFORMATION CARD



Sharper Image Listening Device

Listening Device

It might look as if the user is quietly listening to a portable radio but, in reality, he could be listening in on a conversation from across the room. The *Listenaid II*, available from *The Sharper Image* (650 Davis St., San Francisco, CA 94111), slips into a shirt pocket and, according to the catalog, "literally gives you super hearing." The device can pick up a whisper from 25 feet away and amplifies it using the microchip circuitry inside the small case (just 4 inches high, weighing 3 ounces.) In addition to listening in on conversations, the device is useful for people with hearing problems. The Listenaid II can help users hear better in movie theaters or while watching television. The device includes headphones and uses a 9-volt battery. Price: \$59.

CIRCLE 44 ON FREE INFORMATION CARD

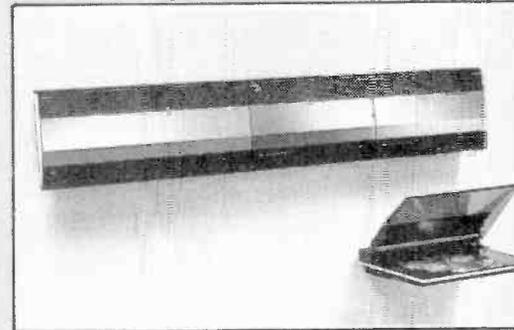
For more information on any product in this section, circle the appropriate number on the Free Information Card.

ELECTRONICS WISH LIST

Wall-Mountable Music System

Short on space but long on style? The new *Wall-Mountable Music System* from *Bang & Olufsen of America, Inc.* (1150 Feehanville Dr., Mt. Prospect, IL 60056) may be just what the interior decorator ordered. The remote-controlled *Beosystem 4500* incorporates a receiver, a CD player, a cassette recorder, and a turntable and is finished in mirrored aluminum and black plexiglass. According to Bang & Olufsen, "music from the 4500 can be transported to additional rooms by installing Master Control Links and adding speakers in either passive or powered versions." Price: \$2,698.

CIRCLE 45 ON FREE INFORMATION CARD



Bang & Olufsen Wall-Mount Music System

Clock Calendar

Wondering what day of the week your 100th birthday falls on? Or worried about waking up at 7:30 tomorrow morning? The *Generation Calendar* from *Synconics* (Hanover, PA 17333) answers both needs. It's an electronic clock/calendar that is preprogrammed for the next 40 generations and it also tells the current date, time, and day. It allows the user to set 16 different alarms, including one for the morning of the user's 100th birthday. It has a memo function that flashes reminder dates. Measuring a trim 3½- by 4¾-inches, it fits neatly on a desk or in a briefcase. Price: \$49.95.

CIRCLE 46 ON FREE INFORMATION CARD

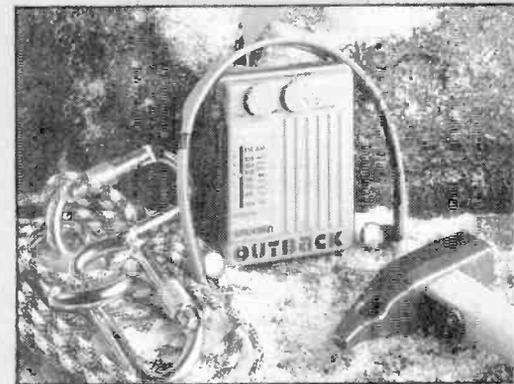


Synconics Clock Calendar

Outback Walkman Radio

Campers want quality and they want toughness, whether it's in their choice of hiking boots or a portable radio. Here's a radio from *Sony Corp. of America* (Sony Dr., Park Ridge, NJ 07656) especially designed for the rough and tumble of camping and hiking. The *Outback Walkman Radio (SRF-75)* is "small and sturdy enough to take to any terrain" and is coated in elastomer, an ultra-durable rubber compound that helps protect the unit from shock, moisture, sand, and dirt. The AM/FM radio itself features "Mega Bass" and elastomer-coated headphones. The Outback's outer casing features wide ridges and large, easy-to-grasp controls so that the radio can be gripped while roaring down the Colorado River or walking across the desert. Sony does caution, however, that the Outback radio "is not meant to be immersed in water or come into continuous contact with water." Price: \$59.95.

CIRCLE 47 ON FREE INFORMATION CARD



Sony Walkman Radio

Desktop Facsimile/Telephone

Still haven't selected a fax unit with which to participate in the much touted "facsimile transmission revolution"? Consider the new *Faxline Desktop Facsimile/Telephone* from *Northwestern Bell Phones* (9394 W. Dodge Rd., Suite 100, Omaha, NE 68144). According to the manufacturer, this compact unit includes a "feature phone" with hundred-number speed-dialing capability, memory functions that feature 10 one-touch and 40 two-touch speed-dialing locations, on-hook dialing, pause, hold, and last-number redial. The Faxline's facsimile features include "rapid transmission speeds of group 2 and group 3 compatibility," automatic feed function for up to five pages, automatic line switching, and a large LCD display that indicates function, name, number, and fax-transmission status. Users may also print out a "comprehensive transaction record of the last 40 transmissions sent which will list telephone number sent to, date, time, duration of transmission, number of pages sent and transmission status." The Faxline can also operate as a thermal-paper copier. The unit weighs in at 11 pounds and is sold with a roll of thermal paper, a modular line cord, and a one-year limited warranty. Price: \$2,099.99.

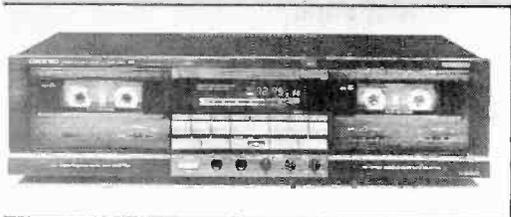
CIRCLE 48 ON FREE INFORMATION CARD



Northwestern Bell Facsimile/Telephone

ELECTRONICS WISH LIST

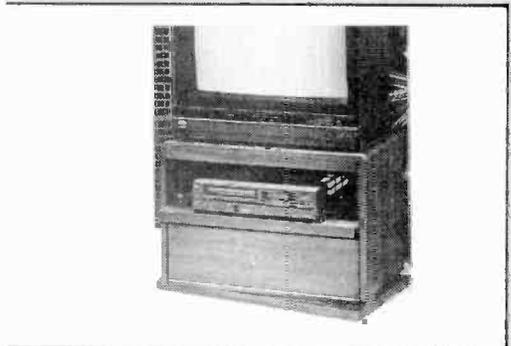
For more information on any product in this section, circle the appropriate number on the Free Information Card.



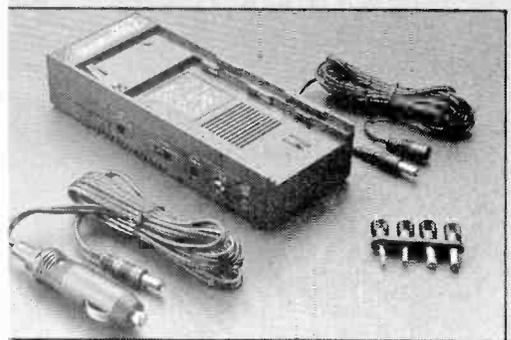
Onkyo Audio Dubbing Deck



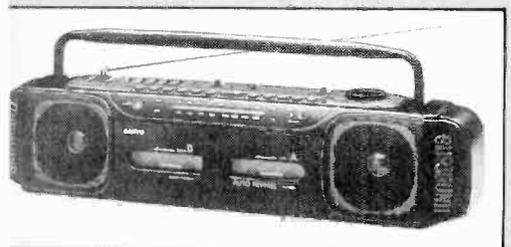
Magnavox Word Processor



Soundesign Swivel-Base Video Stand



Arkon Camcorder/Battery Recharger



Sanyo Stereo Radio/Cassette Player

Audio Dubbing Deck

The dubbing deck was traditionally considered the low end of the cassette-deck market, but with more and more users making their own tapes, those audio decks have rapidly been upgraded. The *Dubbing Cassette Deck (TA-RW470)* from *Onkyo U.S.A. Corp.* (200 Williams Drive, Ramsey, NJ 07446) employs Dolby-B and -C noise-reduction systems to ensure compatibility with other systems and cassettes. The unit uses dual two-motor, logic-controlled transports and provides quick auto-reverse operation for recording or playback. It also uses a real-time tape counter for the record/playback transport to provide accurate elapsed and remaining times for all popular cassette lengths—a particularly helpful feature when editing tapes. Price: \$500.

CIRCLE 50 ON FREE INFORMATION CARD

Word Processor

The dedicated videowriter has become a staple of the home office and small business and now *NAP Consumer Electronics Corp.* (Interstate 40 and Straw Plains Pike, P.O. Box 14810, Knoxville, TN 37914) has introduced a product that combines word processing with the ability to create charts and communicate via external modem. The *Magnavox Videowriter 4500* operates on proprietary, dedicated software that can quickly create bar, line, and pie charts that can be labeled and recalled at any time. The Videowriter also has an RS232 communications port that can transfer ASCII files to any PC or to another Videowriter. It can also transfer documents to fax machines. It has easy-to-understand on-screen instructions, and extensive word-processing capabilities, including thesaurus, spell check, split screen, and block move and delete. Price: \$999.

CIRCLE 51 ON FREE INFORMATION CARD

Swivel-Base Video Stand

Given the space limitations in many homes, electronic-entertainment centers need all the configuration flexibility they can get. *Soundesign Corp.* (400 Plaza Two, Jersey City, NJ 07311) has introduced a *Swivel-Base Video Stand (WC207TP)* that can easily handle a 26-inch television monitor as well as all the accessories that a modern user demands. A pull-out VCR shelf provides handy access to front- or top-loading video units. The entire cabinet swivels, so the VCR and accessories remain within the line of sight along with the television screen. The stand is made of scratch-resistant vinyl veneer with a walnut wood-grain finish. It sits 20 inches high and features a storage compartment for video cassettes. Price: \$49.95.

CIRCLE 52 ON FREE INFORMATION CARD

Camcorder/Battery Recharger

Versatility is always a plus in a battery recharger and the *Camcharger II (MP110)* from *Arkon* (11627 Clark St., Arcadia, CA 91006) works with a range of products from VHS camcorders to cellular-phone batteries. The unit is designed to safely recharge 12-volt NiCd or lead-acid batteries—or it can directly power a camcorder or other 12-volt equipment, including laptop computers and portable stereos. Overcharge and short-circuit protection guard against damage to valuable equipment and the charger's input is protected by an easily accessible and replaceable fuse. Price: \$69.95.

CIRCLE 53 ON FREE INFORMATION CARD

Stereo Radio/Cassette Player

Portable radios come in all sizes and shapes, but the one common characteristic that consumers look for in such a unit is improved sound quality. That's what *Sanyo Fisher USA* (21350 Lassen St., Chatsworth, CA 91311) promises to deliver with its *Surround Sound Slim Line AM/FM Stereo Radio (MW738)*. The company says the system "creates exciting concert-hall ambience" with its Surround Sound system. Specially angled speakers are designed to output the sound "to bounce off walls and adjacent surfaces to recreate the brilliance and depth of a live performance." The player also offers auto reverse in the A deck, a five-band graphic equalizer, and a CD/line capability. Price: \$99.99.

CIRCLE 54 ON FREE INFORMATION CARD

It was just eight short years ago, in 1981, when the first of the IBM PC's were rolled out. Those early machines had just 64 kilobytes of user memory, but the business world was impressed, and the ol' office hasn't been the same since.

The early PC's were great in the office, though they were, at least at the start, too expensive and unfriendly to have games (perish the thought!) played on them. Not only that, but game players, who were sharpening their gaming skills on the PET, Vic-20, TRS-80 Model I, Apple II, and Atari in the early 1980's, looked askance at the stark, no-nonsense, non-graphic green screens of the IBM. Most home-computer gamers couldn't afford IBM's and wouldn't be caught dead playing games on them, anyway.

Things started to change three or four years ago that would cause game production for the IBM PC to surge, to become second only to the Commodore 64 in the multibillion-dollar

computer-games industry. Those factors included 16-bit technology, the development of graphics adapters that would allow the playing of visually enhanced games, and the increased use of color monitors. But the deluge of inexpensive IBM PC clones and compatibles from the Far East was the catalyst that moved the PC from the boardroom to the living room. The bottom line is that 1989 likely will be remembered as "the year of the games" in the PC market.

In this article, we'll survey the world of game software, looking at several different types of games, and the current hot "top ten." We'll also look at different ways of acquiring game software, including all the popular shareware and public-domain titles.

In the Beginning. In the mist-en-shrouded days when the word "computer" meant a room-sized behemoth that only university faculty and students got to finker with late at night,

simple text-adventure games like the generically titled "Adventure" emerged to titillate early game players. Later, a black-and-white stylized electronic version of table tennis, Pong, with its primitive one-dimensional bouncing ball, was launched in 1972 by Nolan Bushnell's Atari. Pong is the game that is considered by many to have ushered in the high-tech game-playing era.

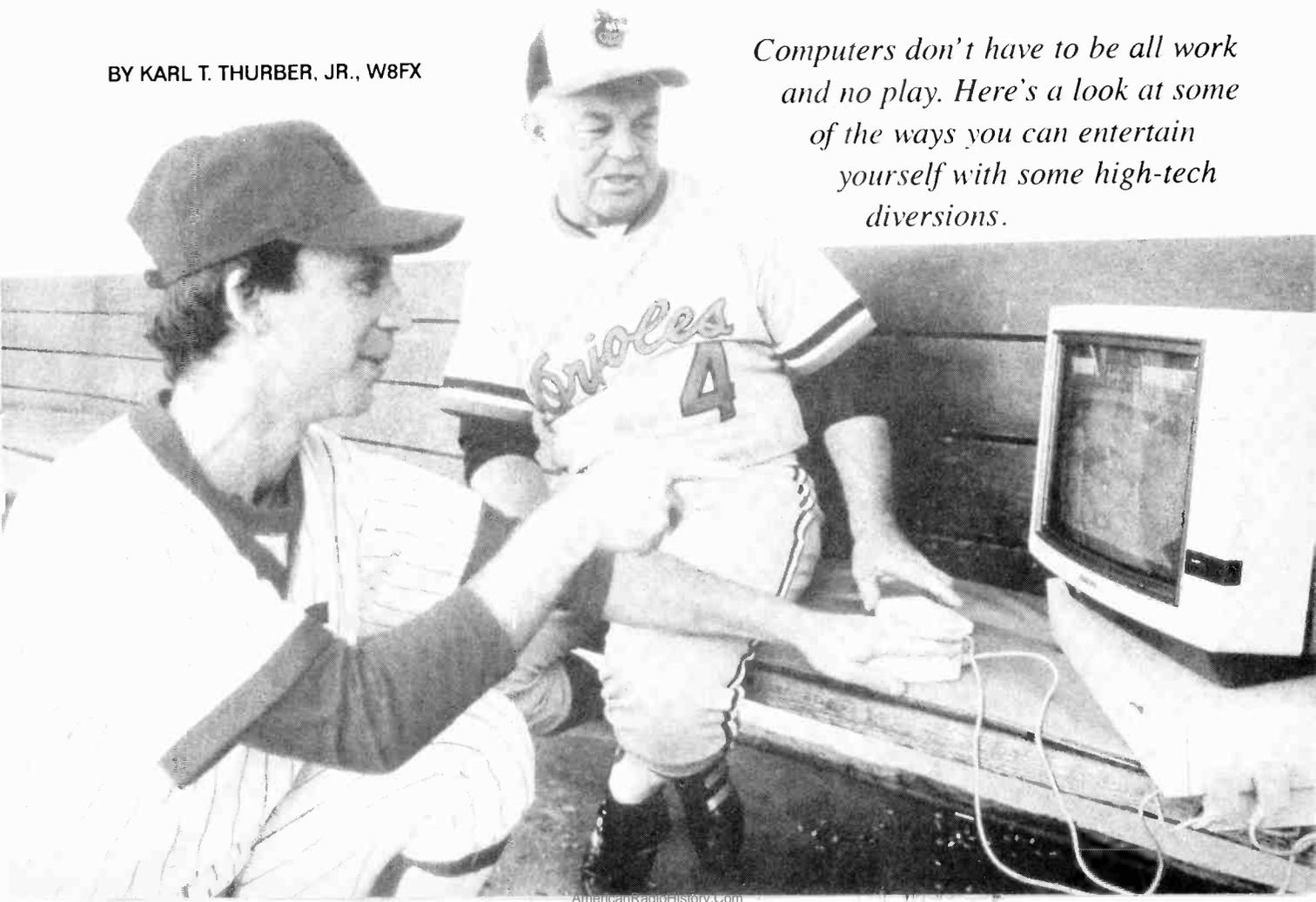
The games revolution continued with the 1977 introduction of Atari's Model 2600 Video Computer System (VCS) that pioneered the innovative concept of interchangeable game cartridges. After the VCS established a games beachhead on the home front, more sophisticated hardware followed, such as Mattel's Intellivision; Coleco's ColecoVision; the Atari 5200 and 7800 VCS game machines; and the systems kids want today, the technologically advanced Nintendo and Sega entertainment systems.

The big problem with the original

Executive Diversions

BY KARL T. THURBER, JR., W8FX

Computers don't have to be all work and no play. Here's a look at some of the ways you can entertain yourself with some high-tech diversions.



Pong, the 4K low-resolution VCS, and the more advanced systems that followed, was that the consumer had to buy a dedicated piece of hardware just to play games, though in the VCS and newer systems, he could at least swap out cartridges for some variety in play action.

Since the late 1970's, when the PET, Apple II, and Radio Shack Model I suggested the then-farfetched possibility of actually using a computer to play games at home, there's been a tremendous amount of progress and sophistication in game software. Many of the advances have been due to such longtime computer game movers and shakers as Scott Adams (Adventure International), Doug Carlston (Broderbund), Joel Berez (Infocom), Trip Hawkins (Electronic Arts), and Ken and Roberta Williams (Sierra On-Line). Even though today's PC wasn't even a glimmer in IBM's corporate eye when many of those folks started out, their pioneering work deserves much credit for the current status of the games we now can enjoy on the PC.

Nevertheless, times have changed: even early 1980's best-selling games like Centipede, Dig Dug, Pac-Man, and Frogger—though still amusing and entertaining—may seem quaintly dated by today's hyper standard of PC-game performance. Each new generation of games seems to be brighter, bigger, faster, and more graphics-and-sound oriented than its predecessors. That is as it should be: today's typical 640K PC has at least 160 times the game-playing capability of the 4K Atari VCS in terms of raw memory alone.

With those factors in mind, let's turn to some of the many types of games you can play with your PC.

Arcade Action Games. Arcade games are probably the biggest sellers, accounting for almost half the different game titles on the market. Those graphics-oriented games are characterized most frequently by the shoot-em-up scenarios featured at arcade galleries, though there are plenty of sophisticated and hybrid types here. Some PC/arcade favorites include Dark Castle (Three-Sixty); Pinball Wizard (Accolade); Impossible Mission II (Epyx); Marble Madness (Electronic Arts); Autoduel (Origin Systems); The Train (Accolade); and Paperboy (Mindscape).



Complexity marks *Starflight*, which lets you explore some 270 star systems and 800 planets and interact with seven alien races, choosing and training six ship's officers. The program includes animated graphics of rotating planets, landing sequences, and more.

Adventure, Fantasy, and Role Playing Games. Adventure games probably are the next most popular type of entertainment software, judging from sales volume. Most of those have you assume a fantasy role (adventurer, detective, gladiator, etc.), with the game presenting you with a series of challenges to overcome. Most accept your commands using English words; some are text-only, while others have coordinated on-screen graphics. Many of the newer games allow you to customize your role-character.

Among the better-executed examples include the Zork series (Infocom); the Kings Quest series, Leisure Suit Larry, and Police Quest (Sierra On-Line); Twilight's Ransom (Paragon/Electronic Arts); the Ultima series (Origin Systems); Defender of the Crown (Cinemaware); and The Seven Spirits of Ra (Sir-Tech). Some of these boast many of the action-oriented characteristics of the straight arcade game.

Gambling, Card, and Board Games. These run the full spectrum of gambling and competitive parlor-game endeavors, from chess games like the Sargon series (Spinnaker), to card games such as Blackjack Academy (Microillusions), Aussie Joker Poker (Mindscape), and Grand Slam Bridge (Electronic Arts) Here, also, are board games like Scrabble (Virgin Games/Electronic Arts), as well as gambler's specialties like Vegas Gambler (California Dreams).

Vehicle Simulations. These types of computer games cover a lot of air, ground, and sea action. Probably the best known members of the category are the flight simulators, where one can vicariously pilot the world's oldest, newest, fastest, or slowest aircraft or space vehicles. Games in this class include such hi-tech favorites as Falcon (Spectrum HoloByte), Chuck Yeager's Advanced Flight Trainer (Electronic Arts), Flight Simulator (Microsoft), Gunship (MicroProse), Jet (SubLogic), 3-D Helicopter Simulator (Sierra On-Line), and Harrier Combat Simulator (Mindscape).

Seaborne games are well-represented, too, by offerings including PT-109 (Spectrum HoloByte), Up Periscope! (ActionSoft), Carrier Command (Rainbird), Sub Battle Simulator (Epyx), and Silent Service (MicroProse). Popular land-vehicle titles include Test Drive (Accolade), 4 x 4 Off Road Racing (Epyx), and Superbike Challenge (Broderbund).

At least one vehicle simulation, Gunship by MicroProse, has spawned a book of simulation scenarios to allow your PC to be your co-pilot. Together with the software you can recreate practically any event in modern helicopter warfare, from Korea to Vietnam to the Grenada invasion, and you can also become involved in the air battles of the 1980's and beyond. The book is *Gunship: 82 Challenging New Adventures* by David Prochnow (TAB Books, \$12.95, 1988).

Sports Simulations and Games.

These games let you get your exercise as a computer couch potato whose biggest exertion is tipping the joystick rather than a bat in pitting your skills against the best.

Some of the more popular PC sports-game simulations include California Games and World Games (Epyx), Hardball! (Accolade), World Class Leader Board (Access), Jordan v. Bird and Earl Weaver Baseball (Electronic Arts), NFL Challenge (XOR), MISL Soccer (Mindscape), and Downhill Challenge (Broderbund).

Strategy and War Games. Here, you can pit yourself against the most brilliant military minds in history, participate in World Wars I, II, and III (!), make a killing on Wall Street, and even design your own futuristic wars. Some currently popular titles include Gettysburg: The Turning Point, Rebel Charge at Chickamauga, and War-game Construction Set (Strategic Simulations); Star Fleet I and Star Fleet II (Interstel/Electronic Arts); Millionaire II (Blue Chip); Wizard of Wall Street (Broderbund); The Hunt for Red October (Datasoft/Electronic Arts); and Universal Military Simulator (Rainbird).

Difficult-to-Classify and New-Breed Games. As PC games become more sophisticated and complex, pushing graphics, sound, and memory capabilities to their limits, many forward-looking game designers have pro-

duced games that don't fit neatly into any of the categories. In the last couple of years, entirely new categories of games have been devised, including multidisk masterpieces that blend elements of arcade and graphic adventure games with pop-out-of-the-screen three-dimensional images. Often, those games allow increased personalization and customization, make use of speech synthesis, and have a smart and sophisticated interactive capacity to adapt to the player's style and skill.

Some new and innovative titles in this hard-to-define area, many with entirely original entertainment formats, include such outstanding implementations as Rocket Ranger and The Three Stooges (Cinemaware); the "Where is Carmen Sandiego" series and The Toy Shop (Broderbund); Jeopardy and Wheel of Fortune (Sharedata); Starflight and Robot Rascals (Electronic Arts); and Tetris (Spectrum HoloByte), the latter being the first Russian computer game to make it to the West. Many adults will enjoy off-beat selections such as Dr. Ruth's Game of Good Sex (Avalon Hill) and Strip Poker II (Artworx).

Top Ten IBM PC Games. Confused at this point as to what games are "the best of the best?" Probably so. What type of PC game you'd prefer, we can't predict: everyone has his own personal opinion on game software. However, we can give you a point of

reference by telling you about the games that are standing the test of the marketplace by racking up big-bucks.

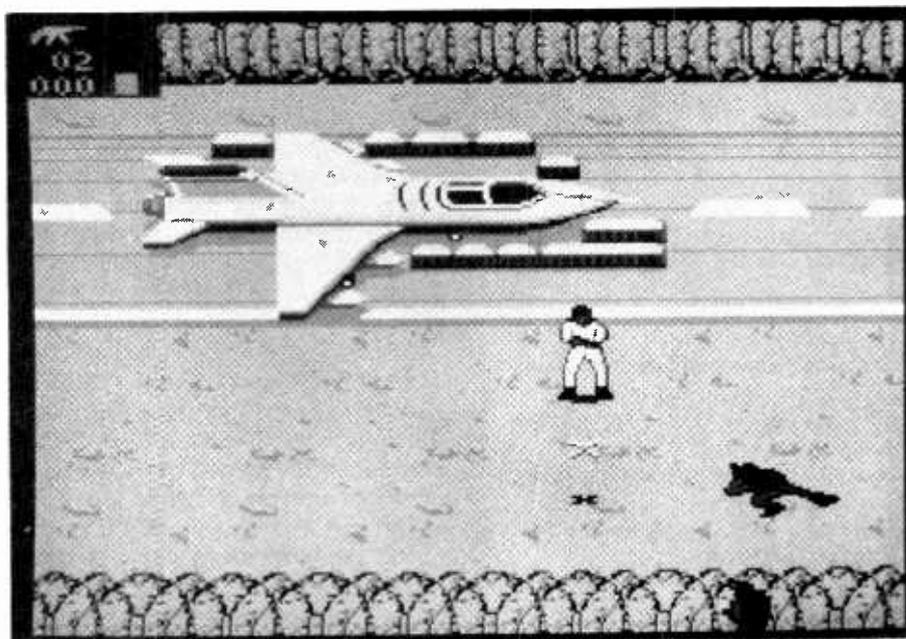
Rankings of best-selling game software probably change almost as frequently as do top-40 record rankings, so there's some risk in assigning actual numbers. Let's just say that these ten games—in alphabetical, and not sales, order, mind you—have been top sellers in recent months:

- California Games (Sports game by Epyx)
- Chuck Yeager's Advanced Flight Trainer (Simulation by Electronic Arts)
- Earl Weaver Baseball (Sports game by Electronic Arts)
- Flight Simulator v3.0 (Simulation by Microsoft Corp.)
- Hardball! (Sports game by Accolade)
- Paperboy (Arcade game by Mindscape)
- Scrabble (Board game by Virgin Games/Electronic Arts)
- T. V. Game Shows (New-breed game by ShareData)
- Test Drive (Vehicle simulation by Accolade)
- Ultima V: Warriors of Destiny (Adventure game by Origin Systems)

Bear in mind that what is one man's gem of a game may be another's fool's gold: there's a real "computer-game jungle" out there. Other computer games that might easily be top-ten contenders on someone else's list include such hot sellers as Gunship and Pirates! (MicroProse), The Hunt for Red October (Datasoft/Electronic Arts), The Toy Shop (Broderbund), World Games (Epyx), Falcon (Spectrum HoloByte), Shadowgate (Mindscape), and Police Quest and Leisure Suit Larry (Sierra On-Line), among others.

The best-selling titles we've indicated won't necessarily be the same for other popular computers, since some types of games play better on one computer than on another, and often the manufacturer doesn't support all machines with his wares.

Making the Purchase? Whether you purchase your hardware and software locally or by mailorder is your choice. Some people like the convenience and assurance of purchasing locally, especially should something go wrong with the purchase. But "something going wrong" is more likely to be the case with hardware and complex productivity software than with games.



Airborne Ranger lets you test yourself as one of America's elite fighting men and embark on desperate solo missions behind enemy lines. Game affords 12 different missions in three regions of the world, and features full-scrolling 3-dimensional animation.

For the most part, there's little risk in buying game software by mail, and you can usually obtain the titles you're interested in at a lower price than locally. However, if you do have a problem, you'll have all the usual hassles of obtaining an exchange—refunds are almost unheard of when it comes to game software.

Besides knowing something more about the mailorder house other than its toll-free number, your best protection against a game-software purchase going bad is to make sure you know the game's specific hardware requirements before ordering. Make sure the software is available for your computer, and double-check memo-

ry, graphics, and joystick requirements; it's fair to expect a mailorder firm to replace defective software, but not necessarily software that you mis-ordered. If you own a PCjr, be sure that the game is designed to work on it in addition to its big brother PC.

Shareware and Public-Domain Games.

The PC world is fortunate to have some excellent public-domain and shareware (try now, pay later) software, more than for any other computer. Public-domain disks are collections of programs that are made freely available by program authors—the programs are not sold, but rather are given away. Typically, a small fee is charged for the costs of the disk, duplication, and mailing, resulting in a charge of \$3-6 per disk. As you might expect, public-domain software runs the gamut from absolutely topnotch to absolutely terrible, though you usually can find some worthwhile games in almost any disk collection.

On the other hand, shareware isn't free. Under the concept, you take a copy of the program (often from the same sources that distribute public-domain software, including computer bulletin boards), and try it out. If you like and use the program, you're expected to send the author his requested fee. This concept has worked reasonably well for PC productivity software, though whether it works as well for games seems doubtful. In any case, those two software types are a vast resource for the game player.

While I'm the first to admit that the very best games are almost always regularly distributed commercial products, it's worthwhile to learn what's out there first, before making some expensive commercial-game purchases. Some of the more popular public domain and shareware games for the PC include such perennial favorites as Amulet of Yendor, Apollo Mission Simulator, Beyond the Titanic, McMurphy's Mansion, Golden Wombat of Destiny, Lotto Fever, PC-Chess, Seawolf, Super Nova, Tune Trivia, Time Traveler, Battle Ground, Striker, and Instant Replay Football—to name just a few low- and no-cost titles.

An important point with public domain and shareware software is that some games require that you have BASIC to run them. In some cases, there may be compatibility problems between the specific BASIC implementation used on your PC and that of the

Computer Game Addresses

For more information on the games listed in this article, contact the manufacturer directly, or circle the appropriate number on the Free Information Card.

Access Software
545 W. 550 S., Suite 130
Bountiful, UT 84010
CIRCLE 100 ON FREE INFORMATION CARD

Accolade
550 S. Winchester Blvd. #200
San Jose, CA 95128
CIRCLE 101 ON FREE INFORMATION CARD

ActionSoft
210 W. Springfield Ave.
Champaign, IL 61820
CIRCLE 102 ON FREE INFORMATION CARD

Artworx
1844 Penfield Rd.
Penfield, NJ 14526
CIRCLE 103 ON FREE INFORMATION CARD

Avalon Hill
4517 Harford Rd.
Baltimore, MD 21214
CIRCLE 104 ON FREE INFORMATION CARD

Blue Chip
7305 W Boston St.
Chandler, AZ 85226
CIRCLE 105 ON FREE INFORMATION CARD

Broderbund
17 Paul Dr.
San Rafael, CA 94903
CIRCLE 106 ON FREE INFORMATION CARD

California Dreams
780 Montague Expwy, Suite 403
San Jose, CA 95131
CIRCLE 107 ON FREE INFORMATION CARD

Cinemaware
4165 Thousand Oaks Blvd.
Westlake Village, CA 91362
CIRCLE 108 ON FREE INFORMATION CARD

Electronic Arts
P.O. Box 7530
San Mateo, CA 94403
CIRCLE 109 ON FREE INFORMATION CARD

Epyx
600 Galveston Dr.
Redwood City, CA 94063
CIRCLE 110 ON FREE INFORMATION CARD

Infocom
125 Cambridge Park Dr.
Cambridge, MA 02140
CIRCLE 111 ON FREE INFORMATION CARD

Microworld
17408 Chatsworth St.
Grenada Hills, CA 91344
CIRCLE 112 ON FREE INFORMATION CARD

MicroProse
180 Lakefront Dr.
Hunt Valley, CA 21030
CIRCLE 113 ON FREE INFORMATION CARD

Microsoft
16011 NE 36th Way
Redmond, WA 97017
CIRCLE 114 ON FREE INFORMATION CARD

Mindscape
3444 Dundee Rd.
Northbrook, IL 60062
CIRCLE 115 ON FREE INFORMATION CARD

Origin Systems
136 Harvey Rd., Building B
Londonderry, NH 03053
CIRCLE 116 ON FREE INFORMATION CARD

Rainbird
P.O. Box 2227
Menlo Park, CA 94026
CIRCLE 117 ON FREE INFORMATION CARD

ShareData
7400 W. Detroit St, Suite 170
Chandler, AZ 85226
CIRCLE 118 ON FREE INFORMATION CARD

Sierra On-Line
Box 485
Coarsegold, CA 93614
CIRCLE 119 ON FREE INFORMATION CARD

Sir-Tech
P.O. Box 245
Ogdensburg, NY 13669
CIRCLE 120 ON FREE INFORMATION CARD

Spectrum HoloByte
2061 Challenger Drive
Alameda, CA 94501
CIRCLE 57 ON FREE INFORMATION CARD

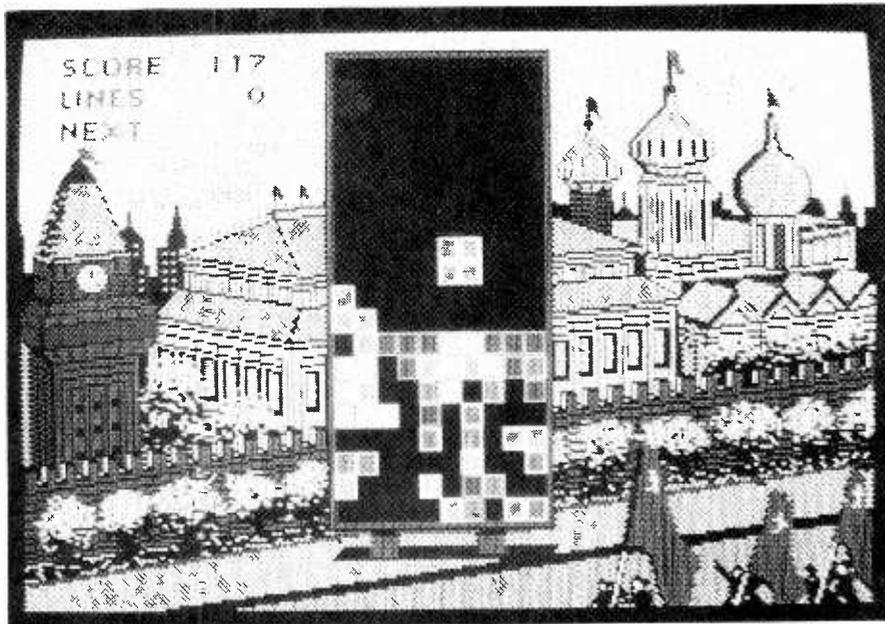
Spinnaker
One Kendall Square
Cambridge, MA 02139
CIRCLE 58 ON FREE INFORMATION CARD

Strategic Simulations
1046 N. Rengstorff Ave.
Mountain View, CA 94043
CIRCLE 59 ON FREE INFORMATION CARD

SubLogic
501 Kenyon Rd.
Champaign, IL 61820
CIRCLE 60 ON FREE INFORMATION CARD

Three-Sixty
2105 S. Bascom Ave., Suite 290
Campbell, CA 95008
CIRCLE 61 ON FREE INFORMATION CARD

XOR
5421 Opportunity Court
Minnertonka, MN 55343
CIRCLE 62 ON FREE INFORMATION CARD



High-resolution EGA screen from Tetris, said to be the first computer game from the Soviet Union. The game may be very roughly described as a sophisticated, animated jigsaw puzzle in a slick computer-game format.

software. Occasionally, you may have to rewrite some "problem lines" in a BASIC program in order to make it work for you.

There are several ways to find what shareware or public-domain software is available. One easy way is to browse through the classified ads of the major computer magazines, sending for catalogs that advertise such software. If you own a modem, you can log onto one of the commercial services such as CompuServe, or onto one of the thousands of free bulletin-board systems (BBS) that are found in all parts of the country that have downloadable software libraries. Some hobbyist-operated BBS's even specialize in games, of which many hundreds are available at little or no cost to the modem user on these on-line systems.

One excellent source of public-domain and shareware software is the PC Software Interest Group (PC-SIG), located at 1030 D East Duane Ave., Sunnyvale, CA 94086. (phone 800/245-6717). PC-SIG has effectively become the "library of record," so to speak, for such software, and now has around 1,000 disks in their collection (including at least 75 game disks) that may be purchased for \$6 per disk. Not only that, but they have placed their entire software library on a CD-ROM disc, selling the CD-ROM and catalog for much less than the cost of individual floppies. Many public libraries subscribe to PC-SIG's CD-ROM service

and allow you to bring in blank disks and freely copy any of the programs that interest you—games, of course, included.

I've found another excellent source of public domain and shareware software to be Public Brand Software, P.O. Box 51315, Indianapolis, IN 46251 (phone 800/426-DISK). Their library isn't as extensive as PC-SIG's collection. But they publish a free catalog that runs over 100 pages (PC-SIG's catalog isn't a freebie). What distinguishes Public Brand Software from other comparable services is their catalog's software rating scheme. They award from one to four stars for each program and one star to "trophy class" for each \$5 disk that they offer, in addition to providing capsule descriptions of each program. Their catalog also describes compatibility requirements for each program and disk. The ratings, descriptions, and compatibility information make their catalog an outstanding, even invaluable, public-domain and shareware software resource.

Another firm that helpfully provides ratings for the public-domain and shareware disks it sells is Computer Solutions, P.O. Box 354, Mason, MI 48854 (phone 800/874-9375). A recent catalog from them is over 60 pages thick and includes 19 games disks, including at least one specifically for EGA color display. Their disks are a reasonable \$4.50 each.

DAK Industries, Inc.—the folks who put out the glitzy electronic specialties

catalogs—has collected two disks chock full of the kinds of public domain and shareware software (including many games) that you might download from public BBS's, offering them for the bargain-basement price of \$3, plus \$1 postage and handling (total \$4); order as No. 4889. They also offer an up-to-date listing of more than 2,000 BBS's across the U.S.A. that you can access with your modem, for \$2 plus \$1 postage and handling (total \$3); order as No. 4888 (California residents should add tax). DAK has set up a special P.O. box for the offer that's different from its regular catalog orders. Send your order with checks only (no cash or credit cards) with the words "LIST" and/or "DISKS" to DAK, P.O. Box 3045, Canoga Park, CA 91306. (The offer is described in the regular DAK catalog, which can be obtained by writing to DAK Industries, Inc., 8200 Remmet Ave., Canoga Park, CA 91304, or by calling 800/888-7808.)

On-Line Gaming. If you own a modem, you may also wish to play on-line computer games over the telephone lines with like-minded enthusiasts across the country. Available game choices range from arcade-style action games and golf simulations to text adventures, sophisticated card games, flight simulators, role-playing games, games modeled on TV game shows, space-battle simulators, various multiplayer games, and more.

In addition to allowing you to play the games on-line, most services offers a compartment or "room" outside the actual game environment, such as an on-line forum or bulletin board, where you can discuss game points and strategies with other enthusiasts and make arrangements for play.

Two popular services that offer online gaming suitable for IBM PC play are CompuServe, 5000 Arlington Centre Blvd., Columbus, OH 43220 (phone 800/848-8199) and GENie, 401 North Washington St., Rockville, MD 20850 (phone 800/638-9636). To play online, you must establish an account with the service and obtain a starter kit, either directly from the service or from a computer store. Some modem manufacturers pack starter kits with their modems to help you get going.

All this fun isn't really free, of course. GENie charges about \$5 per hour, while CompuServe charges about
(Continued on page 105)

RESTORING VINTAGE SPEAKERS

The loudspeakers used in vintage radio receivers are many and varied. They range from primitive horns to permanent-magnet types, with electrodynamics in between. This month, we take a look at some of these ancient speakers, and the problems they pose for the antique-radio enthusiast.



BY JOHN HILL

Radio programs in the mid-1920's were, in the main, listened to on headphones—an arrangement that was hardly satisfactory for family listening. Although loudspeakers were available at the time, they were very expensive.

There were many ways of overcoming that problem. One method was to place the headphones into a large bowl so that the sound was "amplified" by the shape of the bowl, thus allowing many listeners to hear the program. Apparently, there was great debate at the time as to whether a crystal or wooden bowl gave the better tone!

Another early loudspeaker alternative was an acoustic adapter that connected a pair of headphones to a number of stethoscope-like attachments. That gadget provided multiple listening stations from the one set of phones.

Still another interesting technique used a record-player arm to "amplify" the sound. The needle was placed on the headphone diaphragm, thus redirecting the sound through the record-player's horn for all to hear.

This story first appeared in *Silicon Chip*, Australia (November, 1988); reprinted with permission. Lead photo courtesy Orpheus Radio Museum, Ballarat, Australia.

Commercial Loudspeakers. At the time, commercially produced speakers operated on a similar principle to headphones and were nothing other than a large single headphone piece with a sound horn attached. While we may smirk about such things today, in the 1920's a horn speaker was the last word in loudspeaker technology.

Of course, the sound reproduction of the old horn speaker left much to be desired. It had a high-pitched metallic sound that totally lacked bass or any tonal quality. There was plenty of room for improvement, and improvements there were.

In a time span of just several years, loudspeakers went through several stages of development, including some cone types of incredible size. But none of those did much to really improve the quality of the sound until the dynamic or moving-coil loudspeakers came on the scene. The moving-coil speaker was the big breakthrough in speaker technology and modern speakers are the result of on-going refinement of that original idea.

To my knowledge, nearly all of those very early loudspeakers, prior to the dynamic speakers, were permanent magnet types. However, the early dynamic speakers, up until the late

1940's, were mostly electrodynamics, where the speaker magnet is an electromagnet. That development went hand in hand with the ever increasing use of AC-powered sets.

Early AC sets used a high-voltage choke to filter or reduce the 60-Hz power-line hum that is a characteristic of rectified DC. The choke was incorporated in the loudspeaker where it performed the dual role of choke and speaker magnet. That built in choke was known as the "field coil."

When it comes to antique loudspeakers, the one that comes to mind as far as most collectors are concerned is the electrodynamic type. That is the speaker I will concentrate on for most of this article. Horns and the very early cone speakers are relatively rare. The average collector, particularly if he is new to the game, is unlikely to have many radios in his collection that are pre-1930.

On the other hand, collectors who have been scrounging for quite some time are likely to have much from the 1920's era.

Although I am a relatively new collector, I have still managed to collect six horn speakers. However, I have really gone out of my way to get them. I might add that some of them cost per-

haps a lot more than they are worth, but if you want something badly enough you pay the going price.

Keeping it Original. Electrodynamic loudspeakers will vary widely in their general condition. Wherever possible, a collector should endeavor to keep radio as original as possible and the electrodynamic speaker should be either retained or replaced with a similar unit.

Such ideals are not always possible, nor are they very important apart from the originality aspect. If originality is not a matter of life or death, then a more modern permanent magnet loudspeaker is the logical replacement. A modern loudspeaker will usually improve the sound of an old radio quite considerably.

When replacing an electrodynamic speaker with a permag (permanent magnet) type, something must be done about the field-coil circuit. The field coil forms a vital part of the high-voltage circuitry and must be retained if the set is to function correctly. There are several ways of overcoming that problem.

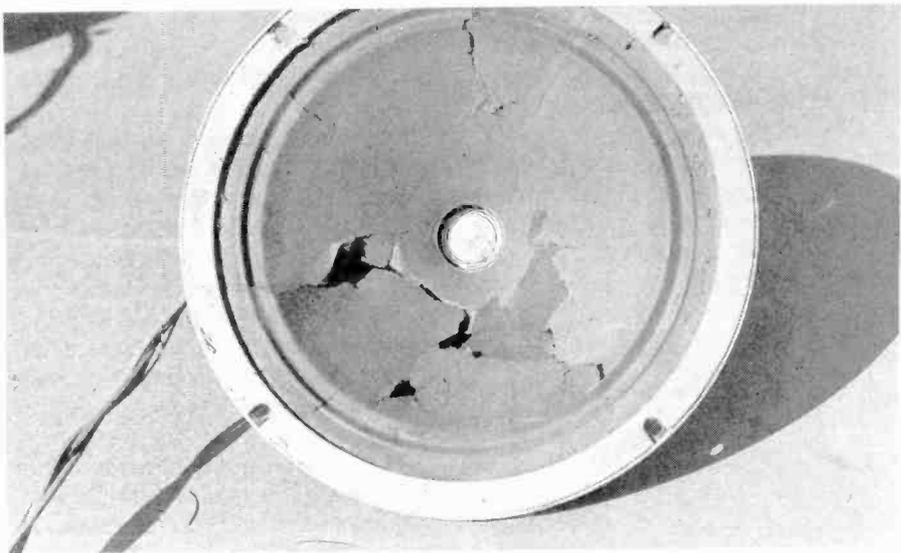
Perhaps the easiest way out is to replace the field coil with a 20-watt resistor of the appropriate value. Field coils generally range in impedance from 1k ohm to 2.2k ohms, although some go as high as 8k ohms.

The substitute high-wattage resistor would need to be of similar impedance to the field coil. The resistor should also be mounted where the dissipated heat will not affect the operation of other components. Use of a heat sink, or a heat-sink-type resistor that can be bolted to the chassis, is recommended.

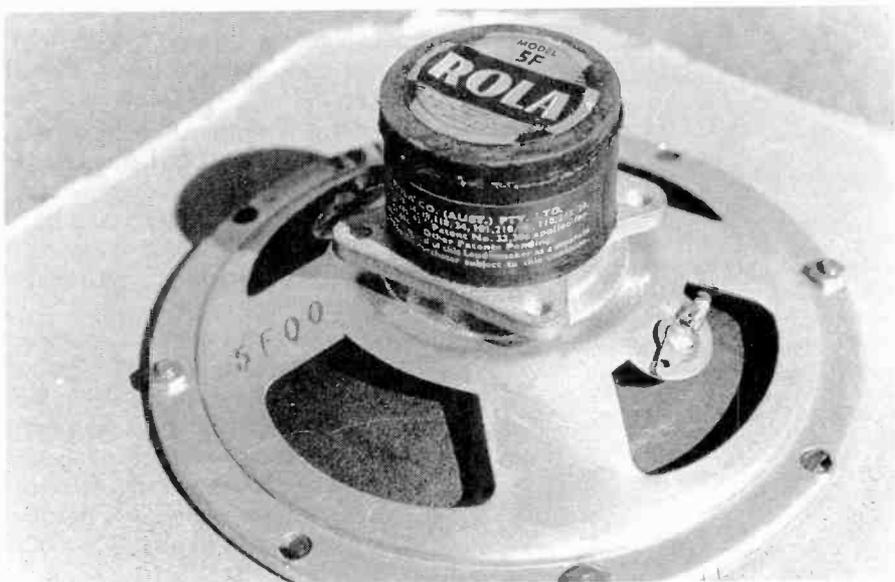
Another way is to substitute a separate choke of the same impedance as the field coil. That can be mounted on or under the chassis, wherever space is available. Unfortunately, suitable chokes are not always available with the desired impedance and you may have to wire a choke and high-wattage resistor in series to match the speaker's field coil.

Still another option is to mount the field coil of the old loudspeaker under the chassis or in some inconspicuous part of the cabinet. While the speaker itself may be unserviceable, the field coil may be quite fine, and there is no reason why it shouldn't be used as a choke.

If desired, both the field coil and the



Speaker cones in this sad state can be made to work again if one is desperate or determined enough. In this case, a replacement loudspeaker would be the best alternative.



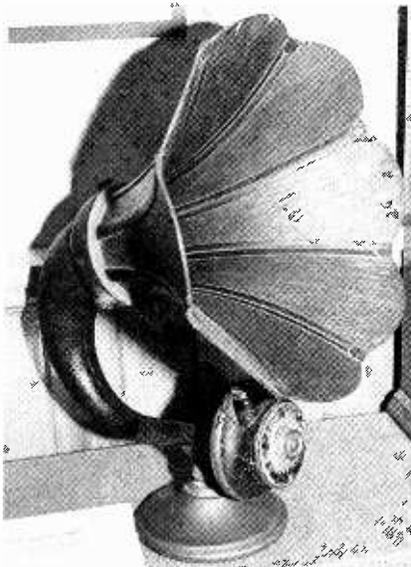
This Rola permag loudspeaker still has the flange and bolt holes where the field coil bolted on in an earlier design. A number of manufacturers retained the field coil frame for some of their early permanent-magnet speakers.



The field coil impedance of an electrodynamic speaker is usually marked on the back of the field coil. If the marking is no longer visible, it can be checked with an ohmmeter.

speaker transformer can be chassis mounted. That has the advantage of keeping all the high voltage confined to the chassis, which is desirable from a safety point of view.

Regarding safety, it is unwise to handle an electrodynamic speaker while the set is operating. It could prove quite a "shocking experience" if the wiring is faulty.



The Amplion "Dragon" was a popular horn-type loudspeaker from the mid-1920's era. By today's standards, it sounded dreadful. (Photo courtesy Orpheus Radio Museum, Ballarat, Australia).



The "spider" at the center of old speaker cones acts as a damper on cone movement and holds the voice coil centered in the gap. If the voice coil is fouling the magnet, the cone can be repositioned by temporarily loosening the screw.

Repairing Loudspeakers. Back in the good old days, when electrodynamic speakers were in common use, they could be rebuilt without much trouble. It was often cheaper to rewind a field coil, fit a new speaker

transformer, or even replace a damaged speaker cone rather than discard the whole unit and buy a new one.

Those old speakers were built to be serviced and all the bits and pieces, including new speaker cones, were readily available. Unfortunately, after 40 years or so, those much needed parts are no longer as commonly available. While field-coil and transformer troubles aren't difficult to solve, speaker cones can be a bit of a problem. Patching the old one is about the only alternative.

I have seen speaker cones in tatters yet they still function surprisingly well. Major splits, tears, and holes seem to make little difference in the sound quality. Often, the only adverse effect is a buzzing sound as the loose bits of cone flap about. If one cares to glue together all the tattered bits, an old speaker cone can be given a new lease on life.

Almost any reasonable glue and thick drawing paper can be used to fill the large holes and missing sections of a damaged cone. It is surprising how well a damaged speaker cone can be repaired if the desire to get it working again is there.

One particular part of a speaker cone that does wear out is the ridge (or ridges) around the outer rim where the cone flexes. Modern speakers often have a special super-flexible synthetic reinforcement strip around the edge of the cone. Such a cone gives greatly prolonged life compared to the old paper type.

Old speaker cones can wear very thin around the rim and holding the speaker up to a strong light will soon reveal any problems. If the light shows through, it is only a matter of time before the cone detaches itself from the rim.

That particular problem is easily solved by applying a generous application of silicone rubber to the grooves at the outer edge of the speaker cone. The rubber compound needs to be rubbed in fairly firmly to ensure that there is good adhesion to the paper.

Silicone rubber seems to be an excellent rejuvenation agent for tired speaker cones. It adheres well to the paper and provides flexibility where it is needed. Although silicone rubber was never intended for such use, it appears to be well suited to the task of restoring loud speakers.

Voice-Coil Fouling. Old electrodynamic speakers often have a terrible buzzing sound in them, which is usually caused by the voice coil at the center of the cone rubbing against the magnet. If the speaker has a centering device (the "spider"), the problem can usually be cured by repositioning the cone.

To do that, first undo the screw in the center that releases the spider. The cone can then be repositioned and the screw tightened again. With a bit of luck, the cone will now work in a position where the voice coil no longer fouls the magnet.

If you don't get it right the first time, loosen the locking screw and try again.

Another way to solve that problem (sometimes) is to remount the speaker upside down. Often a speaker cone sags and distorts a little due to its own weight and the passing of time. Simply inverting the speaker can reposition the cone sufficiently to eliminate the problem. It doesn't always work, but it's worth a try.

Bigger is Better. The sound of an old radio can be improved many ways and one trick is to use a larger speaker than was originally fitted. That can be done without too much trouble with console-type radios because there is usually plenty of room. Fitting a 10 or 12-inch speaker will really make the windows rattle.

Smaller mantle radios can respond to the same treatment, and often a larger speaker can be worked in without too much trouble. Bigger speakers give better sound.

The quality of any sound system depends greatly on the quality of the loudspeaker. Even an old reaction-type radio from the 1920's sounds surprisingly good when played through a modern speaker. The same set through an old horn speaker sounds absolutely dreadful.

In summary, the vintage radio restorer often has to choose between sound quality and originality. Occasionally they can have both for some old speakers perform remarkably well—but, unfortunately, that's not often the case. Many old receivers were seriously handicapped by inadequate loudspeakers.

Loudspeakers, like so many other things we now take for granted, have certainly come a long way in the past 60 years. ■

Most electronic circuits require DC power supplies. Batteries are the cleanest source of DC, but they are not always practical. Alternatively, deriving DC from the AC-power lines requires at least a rectifier and ripple filter. So, in this article we will take a look at how those components are used and, more important, how to select the value of capacitor to be used in the filter.

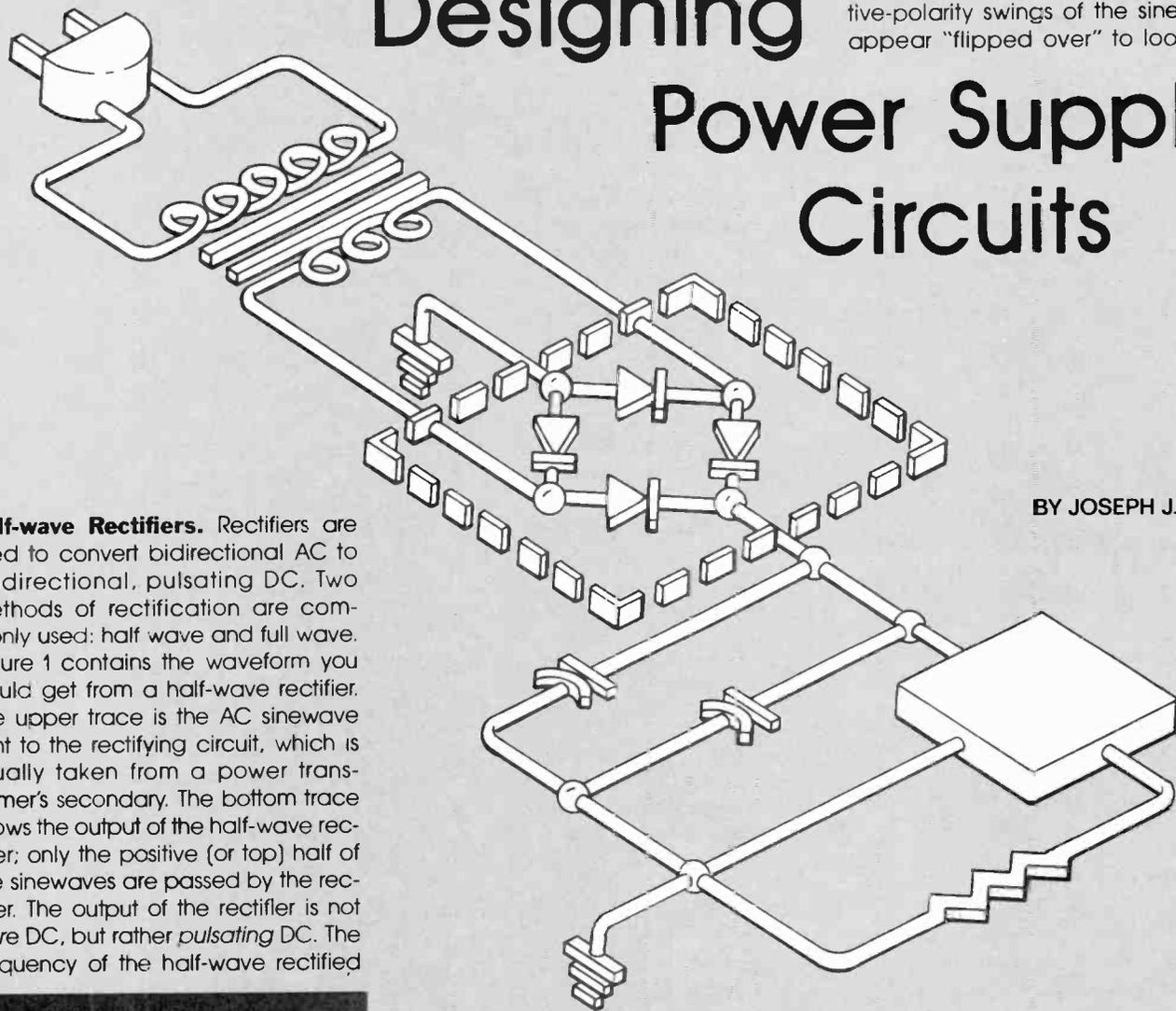
pulsating-DC output is the same as the AC input (e.g., 60 Hz in the USA).

Figure 2 shows the simplest half-wave rectifier circuit possible. The circuit uses a single PN-junction rectifying diode (D1) connected in series with a load, here represented by resistor R_L . When the input voltage to the anode is positive with respect to the cathode (see Fig. 2A), the diode is forward biased so current (I) flows through the

The process would be more efficient if both halves of the AC waveform are used. Waveform filtering will also be less critical if the complete wave is used. Also, in circuits that use a power transformer, for a given output-power level, the primary winding VA (volts times amps) rating must be 40 to 45 percent higher for half-wave rectifiers than for full-wave rectifiers. For those reasons, most DC power supplies use full-wave rectification.

Figure 3 shows the full-wave rectified AC waveform. Notice that the negative-polarity swings of the sinewave appear "flipped over" to look like

Designing Power Supply Circuits



BY JOSEPH J. CARR

Half-wave Rectifiers. Rectifiers are used to convert bidirectional AC to unidirectional, pulsating DC. Two methods of rectification are commonly used: half wave and full wave. Figure 1 contains the waveform you would get from a half-wave rectifier. The upper trace is the AC sinewave sent to the rectifying circuit, which is usually taken from a power transformer's secondary. The bottom trace shows the output of the half-wave rectifier; only the positive (or top) half of the sinewaves are passed by the rectifier. The output of the rectifier is not pure DC, but rather *pulsating* DC. The frequency of the half-wave rectified

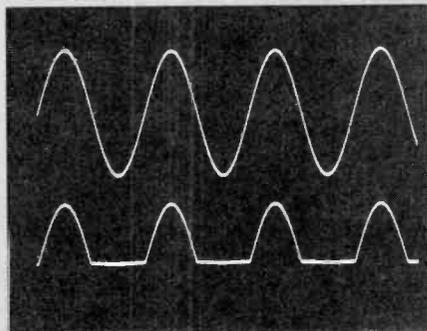


Fig. 1. Here we show how an AC waveform (uppermost) has its lower portion chopped-off by a half-wave rectifier.

load. When the polarity of the input voltage changes (Fig. 2B), the diode is reverse biased, and no current can flow. During that period the output waveform is flat because the negative excursion of the sinewave is clipped off.

Full-wave rectification. Half-wave rectification is cheap and simple, but is also wasteful since only half the available power gets past the rectifier.

Give you tired batteries a well deserved rest by designing a power supply that fits your needs.

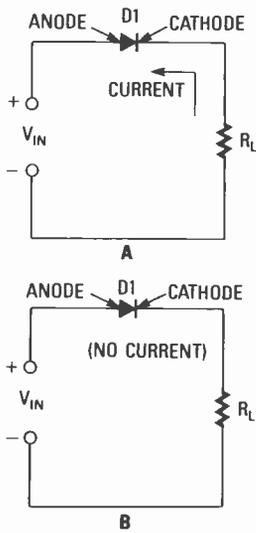


Fig. 2. When the diode is forward biased (A) it allows the AC voltage to be presented to the load. When reverse biased, the diode shuts off and acts like an open circuit (B).

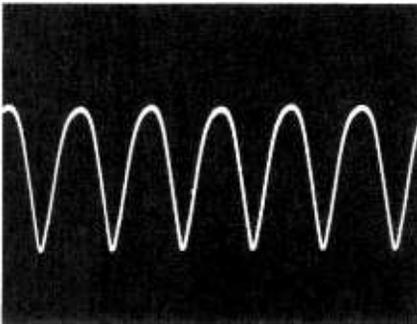


Fig. 3. Full-wave rectification allows both halves of the AC waveform to be used by effectively flipping over the negative excursion through diode switching.

positive swings that fill in the gaps you saw in the half-wave rectified case. The pulsating-DC frequency is twice the AC-input frequency, or 120-Hz in the USA. Let's see how the magic flip over occurs.

Conventional Full-wave Rectification.

There are two basic forms of full-wave rectifier circuits: conventional and bridge. The conventional full-wave rectifier circuit is shown in Fig. 4. The transformer is a center-tapped type, and the center tap is used as the common or ground-reference point. Two diodes are used; each one rectifies one half of the waveform. The cathodes of the diodes are joined together at the positive output, while their anodes are connected to opposite ends of the transformer's secondary winding.

The input sinewave applied to the primary will alternate back and forth between positive and negative volt-

ages. Those alternations are transferred to the secondary, and are applied to the diodes. If the center tap of the transformer secondary is the ground for the output circuit, the voltages at the secondary's far ends will be 180-degrees out of phase with each other. In other words, in Fig. 4, when point "A" is positive (+) point "B" is negative (-). When the input sine-wave reverses polarity, the secondary's polarities reverse. So, point "A" will be negative and point "B" will be positive.

Consider first the situation in which point "A" is positive with respect to the center tap, and point "B" is negative. For those polarities, diode D1 is forward biased and diode D2 is reverse biased. Current flows out of the transformer center tap, through the load (R_L), through diode D1, returning to the transformer at point "A."

On the next half cycle, the polarities reverse so point "A" is negative with respect to the center tap, and point "B" is positive. Diode D1 is reverse biased and D2 is forward biased. Current again flows out of the transformer center tap and through the load resistor, but now it flows through diode D2 and back to the transformer at point "B."

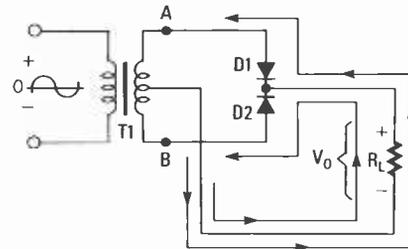


Fig. 4. The arrows on both sides of the supply line going to load resistor, R_L , indicate the current flow during the two half cycles of the waveform.

Notice what happened in the above description: for both polarities the current flows out of the center tap of the transformer through the load resistor. But the direction of the current flow through the load is the same for both polarities. That yields the "double hump" waveform shown earlier. No magic flipping actually occurs, but the circuit effectively "diode switches" the current to simulate it.

Bridge Rectifiers. A bridge rectifier is shown in Fig. 5. In that circuit four diodes are connected in a ring-like fashion. The nodes marked "AC" are connected across the AC source (probably a transformer), while the

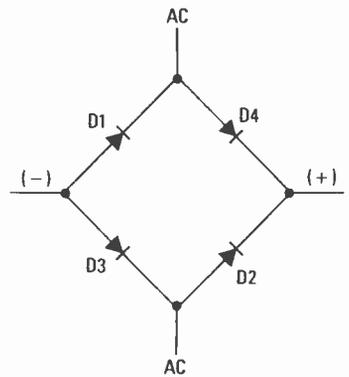


Fig. 5. The diode bridge full-wave rectifies AC without the aid of a center-tapped transformer.

negative and positive pulsating-DC outputs are taken from the adjacent transformer nodes marked + and -.

Figure 6 shows the complete bridge-rectifier circuit and its action. Note that the transformer does not have a center tap, but rather the rectifier is connected across the entire secondary. If the transformer is center tapped, the center tap is not connected. That allows us to use the full secondary voltage rather than only half. However, it is not free. In order to not exceed the primary VA rating, only half the rated secondary current can be used. If the transformer does not have a center tap, then assume that it is intended for bridge rectification, and use the full-rated secondary current.

The circuit action of Fig. 6 can be analyzed in a fashion similar to the conventional full-wave rectifier. Consider first the case where point "A" is positive with respect to point "B." Current flows out of the transformer at point "B," through diode D4 and back to the transformer at point "A." Diodes D1 and D2 are reverse biased, and so they do not conduct.

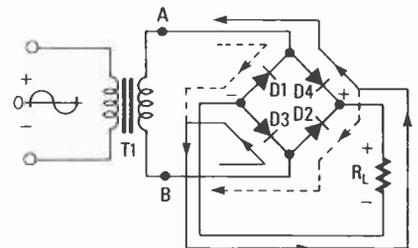


Fig. 6. The solid and dashed lines indicate the flow of current during the two half cycles of the AC waveform. Notice that the current to the load will always travel in the same direction.

On the next half cycle, the polarity of the AC input reverses, so diodes D3 and D4 are reverse biased while D1

and D2 are forward biased. The current leaves the transformer at point "A" (which is now negative with respect to point "B"), through diode D1, the load resistor, diode D2, and back to the transformer at point "B." The direction of the current through the load resistor is the same for both halves of the AC cycle, so the current is being full-wave rectified.

Filter Capacitors. The pulsating-DC output from either full-wave or half-wave rectifiers is almost as useless for electronic circuits as an AC waveform, so a filter circuit is usually used to smooth out the pulsating DC making it a purer DC. Figure 7 shows the simplest form of filter circuit: a single capacitor (C1) connected in parallel with the

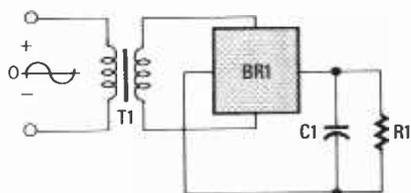


Fig. 7. While a single-capacitor filter may not look significant, if its value is large enough, it can reduce ripple sufficiently enough for many circuits.

load. Its effect on the waveform is shown in Fig. 8. The job of the capacitor is to store the electrical charge received during voltage peaks, and then dump that charge into the load as the voltage drops between peaks.

The value of the filter capacitor is determined by the amount of ripple that can be permitted. Ripple is the effect you get when a small varying voltage rides on top of a DC voltage, which is what a single-capacitor filter outputs. The varying component of the wave is called the ripple voltage. The ripple factor (r) is defined as the ratio of the ripple-voltage amplitude to the average voltage of the rectified waveform. Values tend to be in the range 0.1 to 2.0 for common electronic circuits. The rule of thumb for ripple factor for 60-Hz half-wave rectified circuits is:

$$r = 1,000,000 / (208C1R_L)$$

And for full-wave rectified circuits it's:

$$r = 1,000,000 / (416C1R_L)$$

Where: C1 is the capacitor value in microfarads and R_L is the load resistance in ohms. By the way, the maximum load resistance must equal the max-

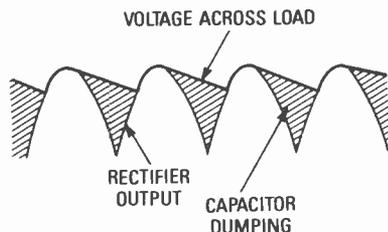


Fig. 8. While the rectifier's output climbs, it charges the filter capacitor. So, when the rectifier voltage starts to decrease, the capacitor discharges through the load providing it with smoother DC.

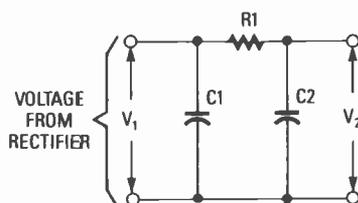


Fig. 9. While pi filters reduce the output voltage and increase the output impedance of a supply, they greatly reduce ripple.

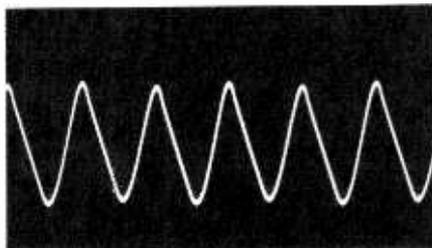


Fig. 10. A close up of the ripple on top of an already filtered pulsating DC looks pretty bad. However, it can be eliminated through the use of a regulator.



Fig. 11. Even at .1 V/division the ripple of a regulated power supply is hard to see. The nasty ripple tamed by the regulator can be seen in Fig. 10.

imum output voltage divided by the output current.

Let's consider a full-wave example: A 12-VDC full-wave rectified power supply delivers 0.5 amperes to the load. Calculate the ripple factor (r) if a 1,000- μ F unit is used for the filter capacitor. Starting out with the full-wave equation:

$$\begin{aligned} r &= 1,000,000 / (416C1R_L) \\ r &= 1,000,000 / (416)((1000)(12/0.5)) \\ r &= 1,000,000 / (416)(1000)(24) \\ r &= 0.1 \end{aligned}$$

So, what do those figures mean in practical terms? In preparing this arti-

cle I tested a capacitor filter's characteristics to illustrate the effect of adding more capacitance to a filter circuit. In all cases, the AC applied to the rectifier was nominally 12 VAC, and the load was 25 ohms. The unfiltered, full-wave rectified, pulsating DC was measured with a DC voltmeter and found to be 9.25 VDC. That value is not the peak voltage (which was close to 12 VDC), but rather an average value caused by the fact that a DC meter tends to average its reading. When a 150- μ F capacitor is connected across the 25-ohm load, the ripple factor reduces to 0.64 (Fig. 7A), and the output voltage rises to 10.86 VDC. Connecting a 1000- μ F capacitor across the load further drops the ripple factor to 0.096 and the voltage rises to 11.86.

Another form of filter circuit is the RC pi-network shown in Fig. 9. Output voltage V_1 is what you would get from a single-capacitor filter, while the output voltage V_2 is slightly lower, but with a substantially lower ripple factor. For full-wave circuits the ripple factor is:

$$r = 2.5 \times 10^{-6} / (C1C2R1R_L)$$

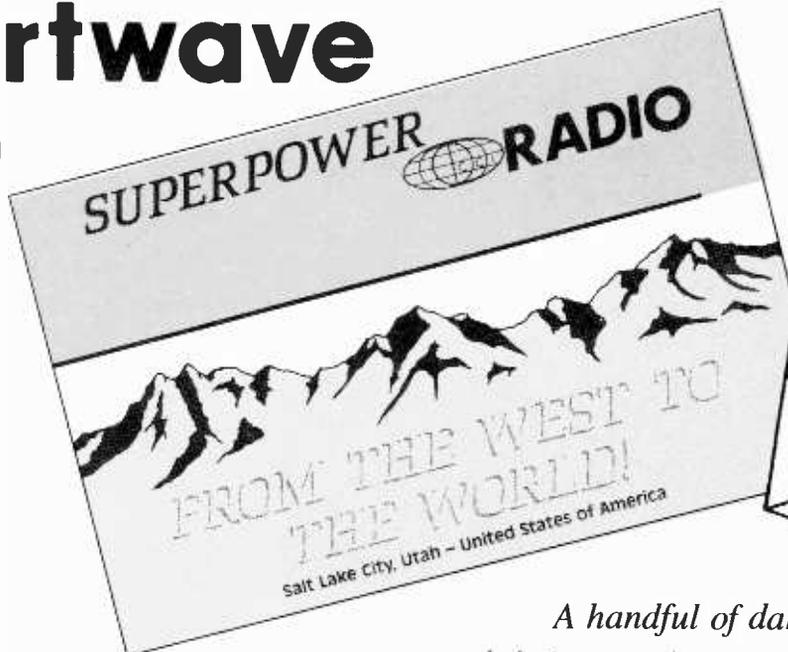
Working Voltage. The other rating for filter capacitors, besides capacitance, is the DC working voltage (WVDC). That rating specifies the maximum voltage that the capacitor can safely sustain on a continuous basis (not at transient peak voltage). Because AC-line voltages can vary ± 15 percent, and the WVDC rating tolerance may have a ± 20 percent tolerance, it is prudent to use a capacitor with a WVDC rating that is at least 1.5 times higher than the maximum output voltage expected from the rectifier.

Regulation. A voltage regulator tends to smooth out the ripple considerably. In fact, a service-shop equipment salesman once told me that his 0- to 18-VDC power supply had the equivalent of one farad of output capacitance. What he meant, however, was the ripple was reduced by a voltage regulator by the same amount as a 1,000,000- μ F capacitor across the load!

Want proof? Examine Figs. 10 and 11, which show unregulated and regulated outputs respectively. Both pictures were shot using the 0.1-V/cm oscilloscope sensitivity, AC coupling, and the same power supply, but Fig. 11 shows a remarkable drop in ripple compared with Fig. 10. ■

U.S. Broadcasters and Commercial Shortwave

BY DON JENSEN



A handful of daring entrepreneurs have turned their attention to commercial shortwave. If they succeed, can the big-time broadcasters be far behind?

There were those who thought I was crazy when I put WRNO Worldwide on the air," says Joseph M. Costello III, who in early 1982 started the first U. S. commercial shortwave station in 40 years.

"Some still do!"

Maybe so, but some of the biggest names in the broadcasting and the publishing industries are beginning to sit up and take notice of Costello's international station, and several others that have joined it in the past few years.

"I can't give you names for publication," says George Jacobs, a consulting broadcast engineer who has been thumping the drum for privately licensed shortwave for more than a dozen years, and who has helped in the set up of most of today's commercial SW stations. "But yes, there are rumblings from several of the 'biggies' about getting into it, too."

There are about 350-million short-

wave receivers in the world, says Jacobs, a former broadcast-engineering official with more than 30 years of experience with the *Voice of America* and *Radio Free Europe*. Ten million of those radios are in North America.

"This is a big audience. If you can reach it commercially, there is money to be made."

Today there are three U.S. commercial-shortwave broadcasters: Costello's WRNO Worldwide in New Orleans; Superpower KUSW in Salt Lake City, Utah; and the *Christian Science Monitor's* stations, WCSN at Scotts Corners, Maine, KYOI on the Pacific island of Saipan, and the soon to be operational WSHB at Cypress Creek, South Carolina. The operating frequencies for those stations can be found in Table 1.

A Little History. Pioneers? Well not really, since it's the second time around for commercial shortwave radio in the

United States. Back in the late 1930's and early 1940's, the two major domestic radio networks and the three big radio manufacturers all tried to make SW pay its way with advertising.

The trigger for that early effort was a Federal Communications Commission ruling in May 1939, authorizing private shortwave broadcasters to begin seeking advertising revenues to offset the roughly \$3 million a year that the stations collectively had been pumping into their experimental broadcasts.

The National Broadcasting Co., which in 1940 operated stations WRCA and WNBI at Bound Brook, NJ (about 30 miles from New York City) was the first to exploit the international medium commercially.

NBC signed the United Fruit Company to a \$25,000-a-year advertising contract. Its sponsorship of the June 20, 1940 Joe Louis-Arturo Godoy fight reportedly drew 35,000 fan letters from listeners in Latin America.

Selling its shortwave airtime for \$300 an hour, NBC soon added sponsors such as Adams Hats, Texaco, Standard Oil, Camel cigarettes, and Kolynos toothpaste, plus a couple of Manhattan hotels: the Astor and the Waldorf Astoria. The next year the network earned \$150,000; not bad, but not enough to lift its overseas commercial operations out of the red.

CBS was much slower in moving into commercial broadcasting; their shortwave outlets, located in Brentwood, Long Island, were WCBX and WCRC. In 1942, when the federal government stepped in to nationalize shortwave broadcasting for the duration of the war, the junior network was just beginning to look for advertising revenue.

Others were also into the commercial-shortwave game. The Crosley Corp., in Cincinnati, had a single 75-kilowatt shortwave station, WLWO, on the air. Its ad rates were lower than NBC's, and it sold one-minute "spots" as well as program blocks. Like its network competition, WLWO audiences were in Latin America, with some of its programs and commercials in English; others were translated into Spanish. The company soon built up a sizable shortwave business with clients like Firestone tires, the Moore-McCormack steamship line, and *The Reader's Digest*.

Other companies that tried commercial shortwave broadcasting, though on a more limited level, were Westinghouse and General Electric. Westinghouse, operating WBOS in

Hull, Massachusetts, in 1941 had but one sponsor. General Electric, which also was looking westward to the Pacific for audiences, had three outlets: WGEA and WGEO, which were located at its Schenectady, N.Y. plant, and KGEI in Belmont, California. Those stations gave free air time to companies—Tidewater Oil, Conde Nast Publishing Co., and American Express among them—that would bear the cost of producing programs.

If the war had not intervened, those early SW-for-profit efforts might have succeeded. As it turned out, commercial shortwave was not revived at war's end. As a money-making medium, it was forgotten until Costello took a chance three decades later.

Now, on its second time around, will advertisers respond to commercial shortwave? That question will be answered over the next few years by the new entrepreneurial SW broadcasters.

Another Try. Jacobs, who retired from government shortwave service to head his own consulting firm, George Jacobs and Associates Inc., is generally credited as being the spark that re-ignited interest in private, commercial shortwave-radio broadcasting in the U.S.

In 1976, or so, Jacobs recalls, he was a luncheon speaker at the National Association of Broadcasters convention in Las Vegas.

"I was speaking about shortwave radio, which was then primarily a government operation. I said, you know, some entrepreneur is going to come along and tap this medium and find a way to make a commercial service make money.

"Joe was in the audience that day, Joe Costello," says Jacobs. "And the bug sort of bit him!"

Costello says his interest in shortwave started when he began listening at age 12. By 15 he had his ham-radio license. In high school he reported for a local broadcasting station and he went on to major in radio and TV production at Loyola University.

He built his first FM outlet in 1967 and later acquired a chain of broadcast outlets and movie theaters in the Gulf states.

Why hasn't anybody done this? Costello asked himself. Why hasn't anyone put a commercial shortwave station on the air?

"The more I asked why, the stronger grew my conviction that it could be



George Jacobs, who has been banging the drum for commercial shortwave for over a dozen years, has helped set up each of the operations on the air today.

done. I had the land for a station. I had the income to underwrite it. I knew I could make it pay!"

Costello applied for his license in 1978, and got his construction permit the next year. On February 28, 1982, WRNO Worldwide went on the air.

Economics and Programming.

Regulations require at least a 50,000-watt shortwave transmitter and a directional antenna system with a 10-dB forward gain. But in this age, Jacobs says, 50 kilowatts of power won't get you very far.

WRNO and the more recently activated KUSH run 100-kilowatt transmitters, which Jacobs says really must be considered regional stations, even though their signals do a decent job in reaching most of the world.

The Christian Science Monitor has opted for 500-kW transmitters, which can offer first-rate worldwide reception, but at a big price tag.

Even a modest 50,000-watt shortwave transmitter and antenna system will run about \$400,000, and that doesn't include a site purchase or engineering and installation costs, says Jacobs.

Published figures indicate Costello, who already had a site and a building, invested \$750,000 in WRNO Worldwide.

And, according to Jacobs, if an entrepreneur wants to set up a 500-kW station, he can spend at least \$2.5 million for the equipment, and a similar sum for land and installation.



Joe Costello is shown here with WRNO Worldwide's 100,000-watt transmitter.

On top of that, the electricity to power a minimum-sized 50-kW short-wave transmitter will cost about \$53,000 a year. Multiply that times 2 or 10, respectively, to fire up a 100- or 500-kW transmitter for a year's worth of programming.

"But," says Costello, "I never saw it as a gamble!"

WRNO Worldwide had been on the air only a short time when Ralph J. Carlson, a 20-year veteran of the broadcasting business with a small string of AM and FM outlets in Utah, Arizona, and Nevada, turned up in New Orleans for another National Association of Broadcasters meeting.

"Joe Costello took several of us on a tour of his new facilities," the Salt Lake City broadcaster remembers. "I was impressed with the future of commercial shortwave and vowed I was going to get into it too."

It took four years, but on December 26, 1987, Superpower KUSW went on the air with its own 100,000-watt station.

"This is a global society today," Carlson says. "Some 35 percent of the cars we drive have foreign nameplates. Try to find an electronic item that's not made in Taiwan or Germany or Korea.

"I felt there is an opportunity with commercial shortwave radio to promote American products to the rest of the world."

But Carlson's KUSW was the third, not the second U.S. commercial short-wave broadcaster on the air.

In mid-March 1987, WCSN, a short-wave offshoot of the widely respected *Christian Science Monitor* newspaper, went on the air from a broadcasting site in rural Maine with a mighty 500,000-watt transmitter.

Though often thought of as just another of the small group of the U.S. religious SW broadcasters, the *Christian Science Monitor's* operation is considerably more. Its programs fall in two distinct categories.

There is, of course, the weekend block of Christian-Science programs, including a broadcast of the Sunday services from the First Church of Christ Scientist in Boston. But on weekdays, and Saturday too, there are the World-Service programs—mostly news, commentary, interviews, and features—which are not only secular, but commercial.

Since WCSN went on the air, its parent organization also bought a failed SW station, KYOI on the island of Saipan, which tried unsuccessfully to

TABLE 1—
U.S. COMMERCIAL SHORTWAVE STATIONS ON THE AIR

STATION	ADDRESS	FREQUENCIES (kHz)
Independent		
WRNO Worldwide	P.O. Box 100 New Orleans, LA 70181	6,185, 7,355, 11,965, 13,760, 15,420
Superpower KUSW	P.O. Box 7040 Salt Lake City, UT 84107	6,135, 6,155, 9,815, 9,850, 11,695, 15,225, 15,580, 15,690
Christian Science Monitor		
WCSN (Maine)	P.O. Box 860 Boston, MA 02123	5,980, 9,495, 9,850, 9,870, 13,760, 15,300, 15,390, 21,640
KYOI (Saipan)	P.O. Box 860 Boston, MA 02123	9,495, 11,900, 15,405, 17,780
WSHB (South Carolina)	P.O. Box 860 Boston, MA 02123	To begin operation later this year

attract a Japanese audience with the translated sound of American rock radio.

KYOI has since been folded into the *Christian Science Monitor* mini-SW network, that is to be joined by a newly built high-powered station on the South Carolina coast by early 1989.

Paying their way. Kent Fricks, general manager of radio marketing for the *Christian Science Monitor* Syndicate, says that the station is taking its venture into commercial shortwave "a step at a time."

Although the church provided the "seed money"—some \$50 million, *Broadcasting* magazine reported—to set up the elaborate and expensive shortwave system, Fricks says the hope is to increase commercial revenue within five years to a level where it will completely pay for the operations.

"It's a matter of developing and growing at this point."

Curiously, it is WRNO Worldwide that has relied most on revenue from religious sources.

"It was true when we started and it is still true today," Costello says, "we carry Gospel programs from a number of the radio ministries.

"For a couple of hours a day and for Sunday mornings, we can get enough revenue from them to cover our operating expenses. Whatever else we earn is a plus."

KUSW's Carlson says his station doesn't derive a major part of its income from paid religious broadcasting, with only one such program on the air. But, he adds, "we're going to do a little more selling of time to the Gospel programs."

It's the Christian Science operation

that has avoided selling religion commercially.

"We're looking at three main forms of funding," Fricks explains. "There are the traditional advertising spots—60 seconds right now, but that could be expanded to 90 or 120 seconds as well.

"Then we're looking at sponsorship of our news broadcasts, and thirdly, a program-underwriting approach similar to that of National Public Radio."

Within its World-Service two-hour program blocks, WCSN began by scheduling merely a pair of one-minute spot commercials. Early in 1988, the number of commercials increased to six and, by late spring, to a dozen, or 10 percent of the 120-minute program block.

Fricks has no plans for a greater concentration of commercial spot announcements at this time.

Advertisers include an international immigration attorney, with offices in Paris, Hong Kong, and California; a company that markets travel products; a firm offering language lesson tapes; an investment newsletter; and others.

"We're trying to find products or services that in some way seem to be useful to international listeners," he says. "We are abiding by the spirit and the letter of the FCC requirement that the advertised products be available in the countries to which we are broadcasting."

That raises the somewhat touchy issue of intended audience.

The rules don't prohibit broadcasting to U.S. listeners, says Jacobs. They approach it in a different way, requiring that the antenna be aimed at an

(Continued on page 107)

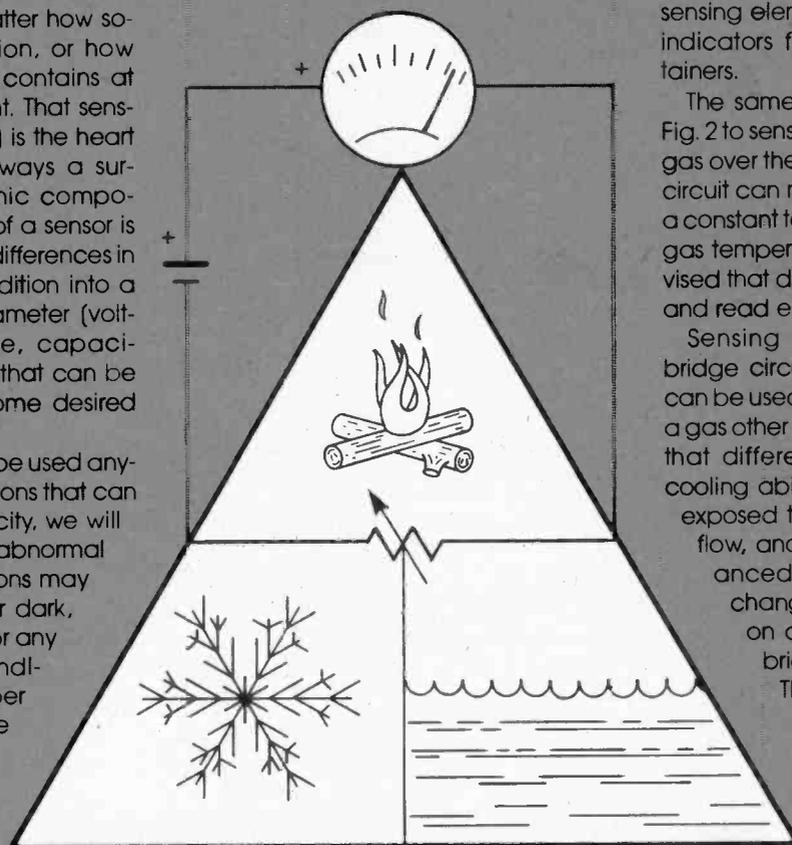
Anyone that has seen the array of electronic test equipment used by auto-repair shops may have wondered how a small gizmo with wires can be put in the exhaust pipe of the automobile to give a read-out of the air/fuel mixture so the carburetor can be perfectly adjusted. Maybe you've wondered how a digital readout of miles-per-gallon is obtained while you are driving your car down the highway. Even if you haven't wondered about such things, there are electronic circuits to measure temperature, moisture, air quality or flow, and small linear motions. For example, hospitals are filled with instruments that read pulse rates, blood pressure, and many other biological parameters.

Every instrument, no matter how sophisticated its application, or how complicated its design, contains at least one sensing element. That sensing element (or elements) is the heart of the device and is always a surprisingly simple electronic component. The basic purpose of a sensor is to convert (or *transduce*) differences in some environmental condition into a change in a circuit parameter (voltage, current, resistance, capacitance, inductance, etc.) that can be processed to achieve some desired result.

Electronic sensing can be used anytime there are two conditions that can be compared. For simplicity, we will call them the normal and abnormal conditions. Those conditions may be hot and cold, light or dark, wet or dry, loud or quiet, or any other two dissimilar conditions. By using the proper electronic element in the proper signal-conditioning circuit, those varying conditions can be converted into a current or voltage to be displayed by some meter, or digital data for digital-display purposes. The sensing elements used can be resistive, capacitive, inductive, optical, or any combination of two or more of those methods. The sensing schemes presented here are just a few of the methods used and by no means represent all of the ways various conditions can be sensed.

Using Resistance. Resistance is used for many sensor applications. Carbon resistors, which date back to the earliest days of radio, have long been

Making Sense of Sensors



Here is a potpourri of electronic sensing methods that can detect anything from air speed to zoo odors electronically

BY W. SCHOPP

known to exhibit a change in resistance with temperature. They decrease in resistance as they get hot.

That is undesirable when a resistor is used in radio circuits. However, in sensing applications it is a useful trait, as we will explain. The resistance change becomes quite pronounced with large temperature variations, such as going from room temperature to very cold cryogenic temperatures. The resistance changes can be detected as a current change or voltage drop across a load resistor in a circuit, see Fig. 1. Enough current is supplied to the circuit to cause a small amount of self heating in the sensing resistor. External cooling of the resistor will cause variations in the resistance. That type of sensing element is often used in level indicators for cryogenic-liquid containers.

The same basic method is used in Fig. 2 to sense the flow or lack of flow of gas over the sensing resistor. The same circuit can measure either gas flow at a constant temperature or variations in gas temperature. Circuits can be devised that distinguish between the two and read either or both.

Sensing resistors in a balanced bridge circuit, such as that in Fig. 3, can be used to detect the presence of a gas other than air by utilizing the fact that different gases have different cooling abilities. If both resistors were exposed to an equal amount of air flow, and the bridge circuit is balanced under that condition, a change in the nature of the gas on one side would cause the bridge circuit to unbalance. The unit can be calibrated to indicate the air quality.

Thermistors evolved by taking the unfortunate resistor-temperature instability and exploiting it further to achieve larger resistance changes with smaller temperature changes. Calibrated thermistors that exhibit a known resistance change over a certain temperature range are now common electronic parts. Positive and negative temperature coefficients, which respectively increase and decrease in resistance with rising temperature, are also available.

Capacitance Variations. Capacitance is often used as the altering circuit parameter a sensing device monitors. Any LC oscillator can be

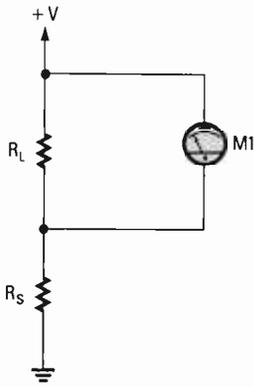


Fig. 1. Variations in the sensing resistor's resistance, R_S , will show up as voltage changes across the load resistance, R_L , for display on $M1$.

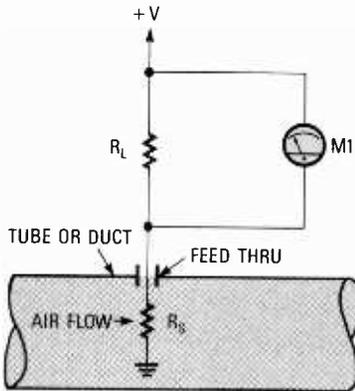


Fig. 2. Current is used to heat the sensing resistor while air flow cools the resistor down. As the resistor's temperature changes, its resistance changes, which shows up on $M1$.

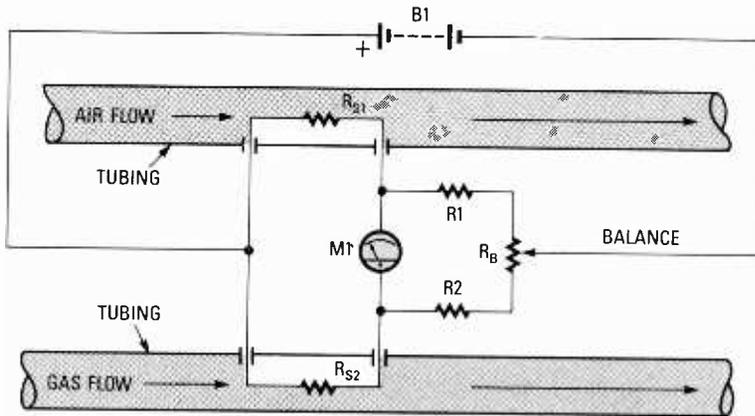


Fig. 3. The flow rate and quality of air can be measured with this device. The circuit is normally balanced 'till some condition in one of the tubes changes.

made to vary its frequency by changing a capacitance (C_S) in its tank circuit (see Fig. 4). With one plate fixed in position, and the other plate movable, the capacitor can be used to measure very small movements of whatever its movable plate is attached to.

Another method of sensing with capacitance changes is shown in Fig. 5. Two identical tuned circuits are driven by a common oscillator. One of the

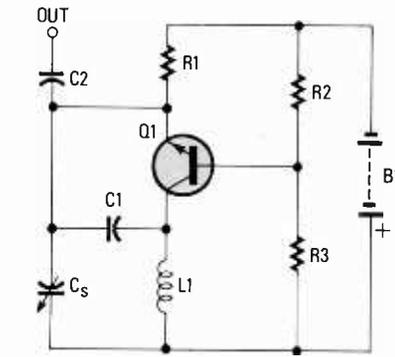


Fig. 4. Changes in the output frequency of this circuit indicate changes in its sensing capacitance, C_S .

circuit contains a sensing capacitor (denoted C_S) and the voltage across the other tuned circuit is monitored with a high impedance voltmeter. When both circuits are tuned, the voltage across the metered circuit will be at a maximum. As the capacitance is changed by the sensing element, a

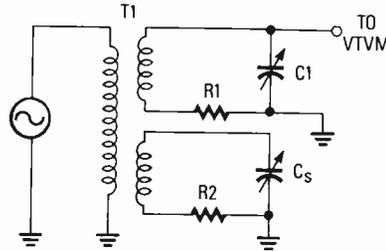


Fig. 5. Even small changes in the sensing capacitance will strongly vary the voltage sent to the VTVM.

voltage change will be detected in the metered circuit. Although the range is limited, the sensitivity is quite high for small changes in C_S .

Inductance Changes. Inductance changes are detected by oscillator circuits just like capacitance changes. In fact, all the capacitance-based circuits described previously can be modified to measure inductance vari-

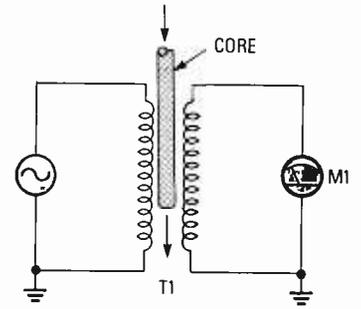


Fig. 6. Movement of the core results in changing the coupling between the transformer windings, and thus the reading on AC meter $M1$.

ations instead of capacitance changes. The inductance of a coil varies with the movement of a magnetically susceptible material placed close enough to it.

A simple method for measuring small linear movements is shown in Fig. 6. A small movable core in the field between the two windings will increase their coupling as the core moves in between them, thereby producing an increasing AC output at the secondary. The windings can be wound together on a hollow form that allows the core to slide in and out of its center. With the proper circuit, that type of sensor can even measure microminch core movements.

A scheme for remotely measuring the height of a magnetically susceptible liquid in a container is shown in Fig. 7. The coil, which is a part of the circuit's LC network, is wound around the glass-tube visual indicator of the tank. A remote readout, made from a specially calibrated frequency meter, can detect the fluid height by reading the oscillator frequency, which changes as the liquid replaces the air as a core for the inductor.

Optics. Many sensing circuits have been designed around optical sensing devices. Among the more common of those are infrared perimeter monitors, burglar alarms, and door annunciators. They all use a focused light source directed at a photo cell and signal an event if the light beam is interrupted. A less common application is shown in Fig. 8. That sensing device can monitor liquid height in an inaccessible location. The optical sensor is composed of two clear plastic or glass rods attached to a prism. When the prism is not in liquid, light from the lamp is directed down one rod and reflects off the inner prism surfaces and back

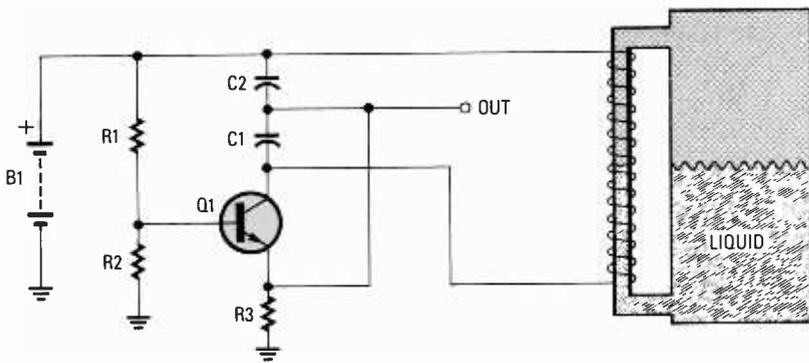


Fig. 7. As the liquid rises or falls in the container, it alters the inductance in the oscillator, and so it alters the output frequency also.

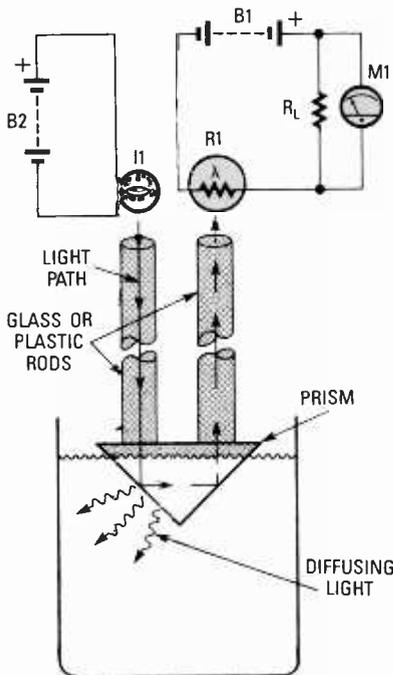


Fig. 8. When liquid wets the side of the prism, it allows the light to diffuse instead of reflecting it.

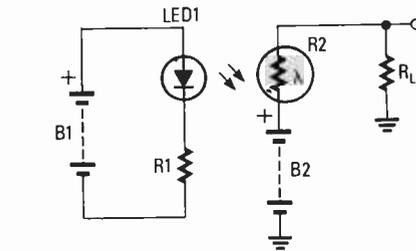
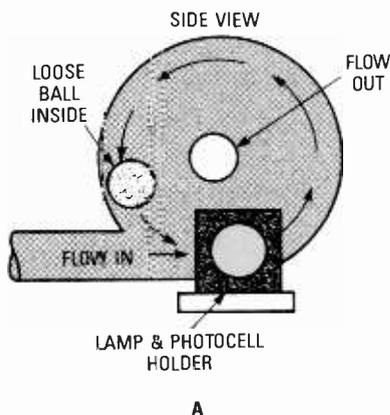


Fig. 10. Interrupted light applications include things such as smoke detectors.

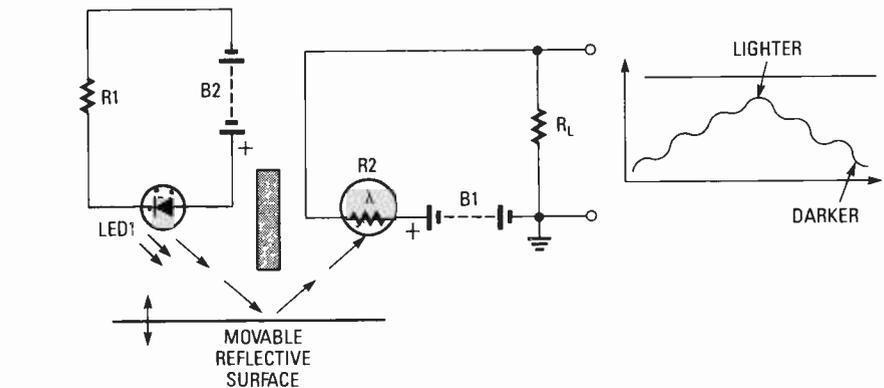


Fig. 11. By placing an LED and LDR close to each other, but separated by a divider, they can be used to indicate the relative proximity of a reflective surface.

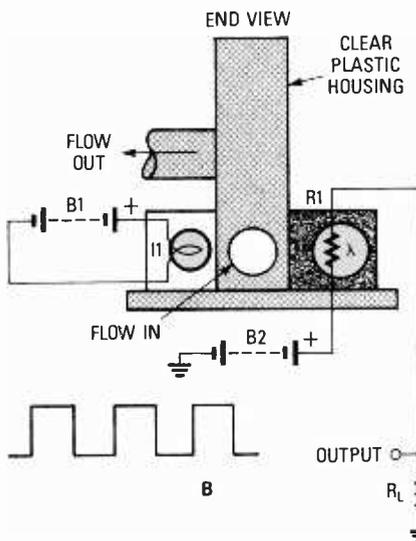


Fig. 9. As you can see in the side view (A) the loose ball is allowed to rush past the lamp/photo cell assembly (B) and the frequency of the pulses produced by the photo cell will be proportional to the rate of flow of the fluid propelling the ball.

to the photo cell. When the prism surfaces are wetted by liquid, the reflective glass/air interface is replaced by the transmissive glass/liquid interface and the amount of light to the photo cell is reduced.

An off-the-wall liquid-flow sensing device based on optical principles is shown in Fig. 9. As liquid flows through the clear-plastic enclosure, a small plastic ball is forced to rotate inside it. The speed of the ball's revolutions is proportional to the amount of liquid flowing through the device. As the ball revolves inside the enclosure, it interrupts the light path from the lamp to the photo cell. That produces a pulse train whose pulse frequency is proportional to the liquid flow. The circuit is easily adapted to digital circuitry since it starts with digital data at the sensor. By using that device to measure gasoline flow and another device that measures mileage, a readout of miles per gallon can be obtained.

Very simple concepts are often used for very sophisticated purposes. Figure

10 shows is a standard LED light source and a photo cell. In that configuration, the sensor can be used for smoke detection, card reading, or any other interrupted-beam application.

When the elements are mounted parallel to each other, as shown in Fig. 11, the unit can be used as a reflective-surface indicator. It can measure either the distance or quality of a reflective surface.

No matter what type it is, the ultimate use of a sensor is to transform the normal and abnormal conditions of something into a current, voltage, or resistance that can be interpolated by a readout circuit. Almost anything can be sensed electronically, and all sensing circuits can make sense if they are studied.

BRANCH-CURRENT CIRCUIT ANALYSIS

BY LOUIS E. FRENZEL, JR.

*Calculating circuit parameters is a snap
if you follow this five-step procedure.*

It is hoped that the rather complex-sounding title hasn't scared you away from this article, since there is actually nothing I'll present that is mysterious or difficult. Sure, it involves a little math, but as you will discover, it is nothing more than the simple algebra you learned in high school. You may have forgotten some of it, but don't worry, I will give you a quick refresher course in basic equations. Then I'll show you some easy ways to solve simultaneous equations. To make it all more interesting and meaningful, I will introduce the branch-current method of analyzing some electronic circuits.

In previous columns, I covered other circuit-analysis methods using Kirchhoff's laws and Thevenin's and Norton's theorems. In this and the next issue, you will learn circuit-analysis methods that result in equations with two or more unknowns. You will apply what you learn to solve those "simultaneous equations," as they are called, for such circuits to find the value of the unknowns.

A Review of Algebra. An equation is nothing more than a statement that two expressions are equal. Expressions consist of constants and variables. A constant is just some fixed numerical value. Typical constants are 1938, -5 , and 0.0029 . Variables are letters (X, Y, Z, etc.) used to represent numerical values that are usually unknown. Some simple equations are:

$$X = 14$$

$$2X - 8 = 12$$

$$5X + 3Y = 67$$

In the last two equations, the variables are preceded by numbers called "coefficients." In the second equation, the coefficient of X is 2. In the last equation, the coefficient of X is 5 and the coefficient of Y is 3. A variable is multiplied by its coefficient. Notice the absence of multiplication signs between variable and coefficients. It is just understood that if variables and/or numbers are placed right next to each other they are multiplied together.

The whole idea of algebra is to manipulate equations in various ways so that you can find the value of some unknown variable. Most of the techniques used to achieve that are pretty trivial, but effective. Let's take a look at some of them.

Addition and Subtraction. One way to solve equations is to add or subtract values. The main rule to remember is that you have to add (or subtract) the same value to both sides of the equals sign to keep the expressions on both sides of the equal sign equal or to keep the equation *in balance*. Here are a couple of examples:

$$X - 7 = 19$$

Our objective is to find the value of X. The basic procedure is to get the variable on one side of the equation by itself and all the other stuff on the other side. For example, to get X by itself in the equation above, we can add 7 to both sides:

$$X - 7 + 7 = 19 + 7$$

The $+7$ on the left cancels the -7 on the left, leaving X as desired. The result is:

$$X = 26$$

In the second example below, the job is to find the value of Y:

$$Y + 11 = 3$$

To isolate Y we just subtract 11 from both sides. The result is:

$$Y + 11 - 11 = 3 - 11$$

$$Y = -8$$

No big deal, right?

Multiplication and Division. You can also multiply or divide both sides of the equation by the same value as a way to help isolate the variable you want on one side by itself. Take the equation we gave earlier:

$$2X - 8 = 12$$

First we get rid of the 8 by adding 8 to both sides:

$$2X - 8 + 8 = 12 + 8$$

The -8 cancels the $+8$ giving:

$$2X = 20$$

We now need to get rid of the coefficient of X, which is 2. So we just divide both sides by 2. That gives:

$$2X/2 = 20/2$$

$$X = 10$$

Here's an example containing a division:

$$Y/5 = 3$$

Note that:

$$Y/5 = \frac{1}{5}Y$$

So $\frac{1}{5}$ is the coefficient of Y. To get rid of that coefficient, all we do is multiply both sides by 5:

$$\begin{aligned} 5Y/5 &= 5 \times 3 \\ Y &= 15 \end{aligned}$$

Simple, huh?

Moving Constants and Variables. As you play around with an equation trying to isolate and solve for a variable, you may need to shuffle the constants and variables around. For example, you may have noticed that when we add or subtract a number from both sides of an equation it's as though we moved the number to the other side of the equal sign and changed the sign of the number. More specifically, it is okay to move constants or variables from one side of the equals sign to the other. If you do, just change its sign. Here is an example:

$$\begin{aligned} X + 7 &= 0 \\ X &= -7 \end{aligned}$$

Another example:

$$\begin{aligned} 2 &= 5 - Y \\ Y &= 5 - 2 = 3 \end{aligned}$$

Sometimes you may end up with an equation like this:

$$9 = -Y$$

You really want the value of Y, not $-Y$. So you could move both 9 and $-Y$ to the opposite sides of the equation changing their signs as you go. That gives you:

$$Y = -9$$

You could also achieve the same result by simply multiplying both sides of the equation by -1 . The values aren't changed, but their signs are:

$$\begin{aligned} 9 &= -Y \\ (-1)9 &= (-1)(-Y) \\ -9 &= Y \end{aligned}$$

Now the Y is on the right rather than the left, but that's okay as we have still solved for the variable.

Sometimes a variable may appear two or more times in an equation. If so, put all occurrences of that variable on one side of the equation and combine them. For instance:

$$\begin{aligned} 8Y - 7 &= 3Y + 21 \\ 8Y - 3Y &= 21 + 7 \\ 5Y &= 28 \\ 5Y/5 &= 28/5 \\ Y &= 5.6 \end{aligned}$$

Practice Problems. Before we go on, blow out the cobwebs with these problems:

1. $X + 8 = -15$
2. $3Y - 5 = 19$
3. $4X + 6 = -7X + 39$
4. $8Y - 12 = 3 + 3Y$
5. $X/6 = 5 - 2X$

Simultaneous Equations. So far we have talked about equations with only one variable. But you will more often encounter equations that contain two or more variables or unknowns. Here are two examples:

$$\begin{aligned} 2X - 3Y &= 5 \\ X + 6Y - 4Z &= 19 \end{aligned}$$

As in one variable equations, our objective is to find values for the unknowns. As it turns out, that is possible only if you have as many equations as there are unknowns. If you have two variables, then you must have two equations containing those variables in order to find a solution. To solve for three variables, you must have three equations and so on. Such equations share or have the same values for the variables. That is why they are called "simultaneous equations." Solving simultaneously is pretty easy as all you have to do is combine some of the tricks and rules given earlier. The basic procedure is to eliminate one of the unknowns, then solve for the remaining variable. You can then plug the value you determine back into one of the original equations to solve for the other variable. The methods for eliminating a variable are called addition, subtraction, substitution, and comparison.

Adding or Subtracting. You can eliminate one variable by adding the two equations or subtracting one from the other to cause one of the variables to cancel out. For instance, take the two equations below:

$$\begin{aligned} 2X + 5Y &= 10 \\ -X - 3Y &= 6 \end{aligned}$$

Adding those equations won't result in the cancellation of either of the variables. But if we multiply both sides of the lower equations by 2, and then add the left side of the first equation to the left side of the second, and the right side of the first to the right side of the second we get:

$$2X + 5Y + (-2X - 6Y) = 10 + 12$$

Which reduces to:

$$-Y = 22$$

or:

$$Y = -22$$

The $2X$ and $-2X$ cancel when we add, leaving only one variable (Y). We know $Y = -22$. So now we go back to one of the original equations, substitute Y, then solve for X:

$$\begin{aligned} 2X + 5(-22) &= 10 \\ 2X - 110 &= 10 \\ 2X &= 110 + 10 = 120 \\ X &= 60 \end{aligned}$$

Just to prove that the values ($X = -22$, $Y = 60$) also satisfy the other equation, let's plug them in and solve it:

$$\begin{aligned} -X - 3Y &= 6 \\ -(60) - 3(-22) &= 6 \\ -60 + 66 &= 6 \\ 6 &= 6 \end{aligned}$$

Which is obviously true.

Here's another example:

$$\begin{aligned} 5X + 8Y &= 14 \\ X + 2Y &= -20 \end{aligned}$$

Let's subtract the two equations. But first, we need to get the coefficients of one of variables equal so they will cancel. So, let's multiply the lower equation by 4 so the Y's will drop out. (We could also multiply the lower equation by -5 to get the X's to drop out.) So we get:

$$-(4X + 8Y = -80)$$

And now adding the left sides and the right sides:

$$5X + 8Y - (4X + 8Y) = 14 - 80 \quad X = 94$$

To find Y, plug the X value into one of the original equations and rearrange it:

$$\begin{aligned} X + 2Y &= -20 \\ 94 + 2Y &= -20 \\ 2Y &= -94 - 20 = -114 \\ 2Y/2 &= -114/2 \\ Y &= -57 \end{aligned}$$

Again, you can verify your values by putting them into the other equation and solving:

$$\begin{aligned} 5X + 8Y &= 14 \\ 5(94) + 8(-57) &= 14 \\ 470 - 456 &= 14 \\ 14 &= 14 \end{aligned}$$

Substitution. Another way to solve simultaneous equations is to solve one equation for one variable in terms of the other. Then substitute that value into

the other equation and solve for the other unknown. Let's start with these equations:

$$\begin{aligned} 2X - 5Y &= -3 \\ 3X + Y &= 8 \end{aligned}$$

Let's use the second equation and solve for Y:

$$\begin{aligned} 3X + Y &= 8 \\ Y &= 8 - 3X \end{aligned}$$

Now, substitute that value for Y in the first equation and find X:

$$\begin{aligned} 2X - 5Y &= -3 \\ 2X - 5(8 - 3X) &= -3 \\ 2X - 40 + 15X &= -3 \\ 17X - 40 &= -3 \\ 17X &= 40 - 3 = 37 \\ X &= 37/17 = 2.176 \end{aligned}$$

To find Y, use the above value of X in either equation:

$$\begin{aligned} 3X + Y &= 8 \\ 3(2.176) + Y &= 8 \\ 6.529 + Y &= 8 \\ Y &= 8 - 6.529 = 1.471 \end{aligned}$$

Comparison. In solving simultaneous equations by comparison, you solve each equation for the same variable, then set the two equations equal. That allows you to solve for the other variable. Finally, you plug your answer into either original equation to find the remaining value. Let's use a now familiar example:

$$\begin{aligned} 2X + 5Y &= 10 \\ -X - 3Y &= 6 \end{aligned}$$

Solving the first equation for X:

$$\begin{aligned} 2X + 5Y &= 10 \\ 2X &= 10 - 5Y \\ X &= (10 - 5Y)/2 = 5 - 2.5Y \end{aligned}$$

Solving the second equation for X:

$$\begin{aligned} -X - 3Y &= 6 \\ -X &= 6 + 3Y \\ X &= -6 - 3Y \end{aligned}$$

Now, set the two X values equal and solve for Y:

$$\begin{aligned} 5 - 2.5Y &= -6 - 3Y \\ 3Y - 2.5Y &= -6 - 5 \\ 0.5Y &= -11 \\ Y &= -11/0.5 = -22 \end{aligned}$$

Using the original equation, we solve for X:

$$\begin{aligned} -X - 3Y &= 6 \\ -X - 3(-22) &= 6 \\ -X + 66 &= 6 \\ -X &= 6 - 66 = -60 \\ X &= 60 \end{aligned}$$

Practice Problems. Now try some of the techniques yourself.

6. Solve the equation below by addition:

$$\begin{aligned} X + Y &= 18 \\ 2X - 2Y &= -44 \end{aligned}$$

7. Solve these equations by substitution:

$$\begin{aligned} 2X + Y &= 6 \\ 3X - 3Y &= 0 \end{aligned}$$

8. Solve these equations by comparison:

$$\begin{aligned} 3X - 2Y &= -21 \\ 5X + 4Y &= -13 \end{aligned}$$

Equations with Three Unknowns.

Some problems result in three unknown variables. To solve such a problem, you need three equations each containing the unknowns. Here's an example:

$$\begin{aligned} X - Y + 2Z &= 16 \text{ (eq. 1)} \\ X - 3Y + 4Z &= 28 \text{ (eq. 2)} \\ 4X + 2Y - 2Z &= 12 \text{ (eq. 3)} \end{aligned}$$

One way to solve such a set of equations is to express one variable in terms of the other two, then substitute the expression into the other two equations. That gives you two equations with two unknowns which you solve by the methods given earlier. Let's do that. First, we'll solve equation 2 for X:

$$\begin{aligned} X - 3Y + 4Z &= 28 \\ X &= 28 + 3Y - 4Z \end{aligned}$$

Now, plugging that expression into equation 1 and reducing yields:

$$\begin{aligned} (28 + 3Y - 4Z) - Y + 2Z &= 16 \\ 2Y - 2Z &= -12 \end{aligned}$$

We can reduce it further by dividing both sides by 2 before solving for Y:

$$\begin{aligned} Y - Z &= -6 \\ Y &= Z - 6 \end{aligned}$$

Putting our expression for X into equation 3 gives:

$$\begin{aligned} 4(28 + 3Y - 4Z) + 2Y - 2Z &= 12 \\ 112 + 12Y - 16Z + 2Y - 2Z &= 12 \\ 14Y - 18Z &= -100 \end{aligned}$$

Dividing both sides by 2 gives:

$$7Y - 9Z = -50$$

Okay, continuing to use the substitution method, let's now solve the two new equations for Y in the new version of equation 1 and solve:

$$\begin{aligned} 7Y - 9Z &= -50 \\ 7(Z - 6) - 9Z &= -50 \\ 7Z - 42 - 9Z &= -50 \\ -2Z &= -8 \\ -Z &= -4 \\ Z &= 4 \end{aligned}$$

Now we can go back to the equation for Y and solve it:

$$\begin{aligned} Y &= Z - 6 \\ Y &= 4 - 6 \\ Y &= -2 \end{aligned}$$

Now we know two of the variables. We put them back into one of the original equations to get X. Let's use equation 1:

$$\begin{aligned} X - Y + 2Z &= 16 \\ X - (-2) + 2(4) &= 16 \\ X + 2 + 8 &= 16 \\ X + 10 &= 16 \\ X &= 16 - 10 = 6 \end{aligned}$$

Review of Kirchhoff's Laws.

Kirchhoff's laws are invaluable for solving complex circuits. There are two versions: the voltage law and the current law.

Kirchhoff's voltage law applies to series circuits. It says that the sum of the voltage drops across the components in a series circuit is equal to the source voltage. For the circuit in Fig. 1, we would write that as:

$$V_1 + V_2 + V_3 = V_s$$

where V_1 , V_2 and V_3 are the voltages across the resistors while V_s is the source voltage.

Sometimes you will hear Kirchhoff's voltage law expressed as "the sum of the voltage drops around a series circuit, including the source voltage, is equal to zero." You can see that in Fig. 1. Note the polarities of the resistor voltage drops. If you follow the direction of current flow from the negative terminal of the battery around the circuit, you

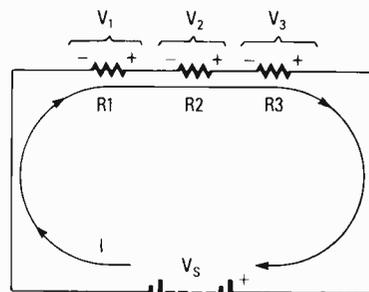


Fig. 1. This series circuit should make Kirchhoff's voltage law obvious. The sum of the voltage drops around the loop must equal the source voltage.

encounter resistor voltages with similar polarities, - to + from left to right. The positive end of R1 is + and it is connected to the - end of R2, and so on. When the polarities are in the same direction, the voltages add. Thus we get:

$$V_1 + V_2 + V_3$$

But note when we get to the source voltage, the polarity is reversed. As you go around the loop, you see the end of R3 is connected to one side of V_S . To show the reversed polarity, we subtract V_S . Then we set the expression equal to zero. The result is:

$$V_1 + V_2 + V_3 - V_S = 0$$

That is the algebraic expression of the voltage law. The expression is really the same as our original expression. All we do is move V_S to the left side of the equation. We change its sign as we do that. That leaves zero on the right side.

Current Law. Kirchhoff's current law applies to parallel circuits (see Fig. 2). It states that the sum of the individual branch currents equals the total cur-

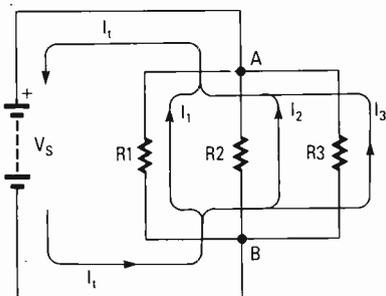


Fig. 2. The current entering a circuit (or any one node) must be equal to the current leaving it, as this circuit makes apparent. Nodes don't have leaks.

rent (I_t) drawn from the source. Algebraically, that is expressed as:

$$I_1 + I_2 + I_3 = I_t$$

In solving circuit problems, you usually start by writing the circuit equation using one of Kirchhoff's laws, then solve for the unknown.

You will also hear Kirchhoff's expressed as "The sum of the currents into a circuit junction (node) is equal to the sum of the currents leaving that junction."

Going back to Fig. 2, you can see that the battery current I_t divides at node B into three currents I_1 , I_2 and I_3 . Therefore:

$$I_t = I_1 + I_2 + I_3$$

At node A, I_1 , I_2 and I_3 come together to form I_t . Or:

$$I_1 + I_2 + I_3 = I_t$$

The Branch-Current Method. A branch of a circuit is one part of a circuit through which a current flows. A simple series circuit has only one branch. A parallel circuit has two or more branches. More complex circuits have two or more branches. We are specifically interested in those more complex circuits with two or more branches since that's where you can use your newly acquired knowledge of simultaneous equations.

A good example is the circuit of Fig. 3, which has two voltage sources. A lot of electronic circuits have two sources,

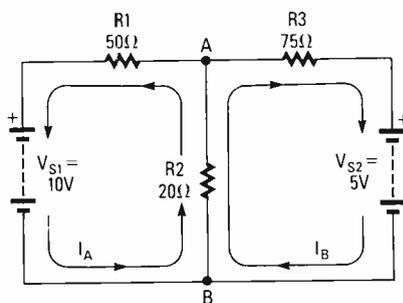


Fig. 3. Two loops for this circuit have been arbitrarily selected to assist us in writing the voltage equations.

so the example we've chosen is a realistic one. Before we see how to solve the circuit, let's give a couple of key definitions.

First, a loop is a complete path in which current can flow. In the circuit of Fig. 3, we indicate two loops. Selecting and indicating loops on a circuit diagram helps us to write the circuit equations that we will solve. They help us establish the signs of the terms in the equations we develop, and determine how many equations we will need to solve the circuit. The choice of loops and their direction is somewhat arbitrary because they only help us to write consistent equations. In fact, we will not be solving for the loop currents, we will be solving for the individual component or branch currents. The loop currents are simply an aid for writing equations. As long as we have enough loops to solve for each branch, we can use them to solve the circuit regardless of direction or of path chosen.

Next, a node is a point in a circuit where two or more loops come together. In Fig. 3, there are two nodes A and B where I_A and I_B come together. Now, how do you solve for the values of

voltage and current in Fig. 3 using the branch-current method? The procedure is outlined below:

1. Assume at least one loop current flows through each branch of the circuit. Draw the individual component currents for each branch. Wherever possible draw them so they have the same direction as the loop currents. (That will help you cut down on the number of negative signs in your equations).

As in Fig. 3, we assume two loops of current, I_A and I_B . We could have used one large loop around the entire circuit along with either I_A or I_B if we wished, since the choice of loops is arbitrary. As long as each branch has at least one current associated with it, we can correctly analyze the circuit.

You can also assume any arbitrary current directions, but for simplicity, let's stick with electron flow from both batteries.

We show all the individual component currents (I_1 , I_2 , and I_3) in Fig. 4.

2. Assign a voltage drop to each component in the circuit and indicate the polarities for all the voltages.

The end of the resistor into which current flows is negative. The end of the resistor out of which current flows is

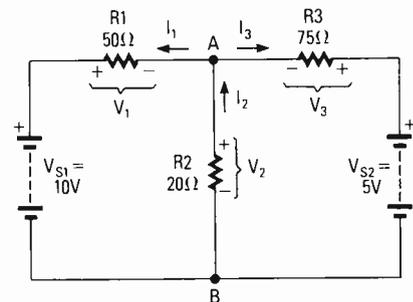


Fig. 4. The three individual branch currents help us determine the polarity of the voltage drops in the circuit as well as the current-node equation.

positive. The polarities are already included in Fig. 4.

3. Write the equations for each loop using Kirchhoff's voltage law.

You just add the voltage drops in each loop and set their sum equal to the source voltage for that loop. For loop A:

$$V_2 + V_1 = V_{S1}$$

And for loop B:

$$V_2 + V_3 = V_{S2}$$

We could've also added all the voltage drops and the source voltage and set them equal to zero like this:

$$V_2 + V_1 - V_{S1} = 0$$

$$V_2 + V_3 - V_{S2} = 0$$

The minus sign in front of the voltage-source terms indicates voltage increases that oppose the voltage drops.

Either way, the equations don't tell us much because the component voltages are unknown. However, you can also write the equations in terms of the currents and resistor values. Remember Ohm's law? The voltage across a resistor is the resistor value times the current, or:

$$V = IR$$

If we substitute the appropriate IR's for the unknown voltages, the equations become:

$$I_2 R_2 + I_1 R_1 = V_{S1}$$

$$I_2 R_2 + I_3 R_3 = V_{S2}$$

or if you use the second method for writing the voltages down, the equations become:

$$I_2 R_2 + I_1 R_1 - V_{S1} = 0$$

$$I_2 R_2 + I_3 R_3 - V_{S2} = 0$$

Either way, we get one equation for each loop.

4. Write the current equations using Kirchhoff's current law using a minimum number of nodes, but so all branch currents are included.

We could write the current equation at node A or node B and include all currents. At node A, the current equation is:

$$I_2 = I_1 + I_3$$

The current into the node (I_2) is equal to the sum of the currents leaving the node (I_1 and I_3).

5. Calculate the branch currents by solving the equations you obtained in steps 3 and 4.

Our previously given loop equations were:

$$I_2 R_2 + I_1 R_1 = V_{S1}$$

$$I_2 R_2 + I_3 R_3 = V_{S2}$$

Putting in the resistor and source-voltage values gives us:

$$20I_2 + 50I_1 = 10$$

$$20I_2 + 75I_3 = 5$$

We now have three unknowns and three equations including the current-node equation:

$$20I_2 + 50I_1 = 10$$

$$20I_2 + 75I_3 = 5$$

$$I_2 = I_1 + I_3$$

Note that while we have three equa-

tions, all of the unknowns appear in each. As we've stated, that's fine just as long as there are three equations. We can use the substitution process described earlier to solve them. Since I_2 is already expressed in terms of I_1 and I_3 , we can just plug that expression in for I_2 in the remaining two equations and solve them. Starting with the first equation:

$$20I_2 + 50I_1 = 10$$

$$20(I_1 + I_3) + 50I_1 = 10$$

$$20I_1 + 20I_3 + 50I_1 = 10$$

$$70I_1 + 20I_3 = 10$$

Doing the same for the second equation:

$$20I_2 + 75I_3 = 5$$

$$20(I_1 + I_3) + 75I_3 = 5$$

$$20I_1 + 20I_3 + 75I_3 = 5$$

$$20I_1 + 95I_3 = 5$$

Now we've got two equations with two unknowns. Let's solve them by substitution also. The two equations are:

$$70I_1 + 20I_3 = 10$$

$$20I_1 + 95I_3 = 5$$

Let's solve the first one for I_1 :

$$70I_1 + 20I_3 = 10$$

$$70I_1 = 10 - 20I_3$$

$$I_1 = (10 - 20I_3)/70$$

Now we plug that into the second equation and solve for I_3 :

$$20(10 - 20I_3)/70 + 95I_3 = 5$$

$$(200 - 400I_3)/70 + 95I_3 = 5$$

$$2.86 - 5.71I_3 + 95I_3 = 5$$

$$89.29I_3 = 5 - 2.86 = 2.14$$

$$I_3 = 2.14/89.29 = .024 \text{ amps}$$

Now we can go back to a previous equation and calculate I_1 :

$$20I_1 + 95I_3 = 5$$

$$20I_1 + 95(.024) = 5$$

$$20I_1 + 2.28 = 5$$

$$20I_1 = 5 - 2.28 = 2.72$$

$$I_1 = 2.72/20 = .136 \text{ amps}$$

Now you can go to the other original equation to find I_2 :

$$I_2 = I_1 + I_3$$

$$I_2 = .136 + .024 = .16 \text{ amps}$$

Practice Problem

9. To understand the process, it is best that you do go through an example yourself. It's a bit of work, but very satisfying and revealing. Try to solve for the currents in Fig. 5. (The loops have already been selected for you, so your solution should be similar to the one provided in the answers to the problems.

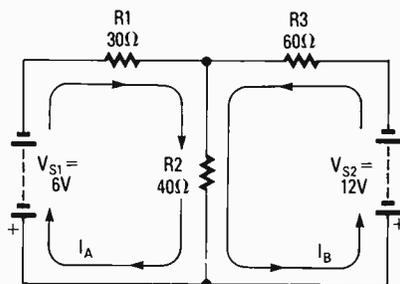


Fig. 5. Using the parts values and loops supplied you must solve for the currents through each component.

Answers to Practice Problems

- $X + 8 = -15$
 $X = -8 - 15 = -23$
- $3Y - 5 = 19$
 $3Y = 19 + 5 = 24$
 $3Y/3 = 24/3$
 $Y = 8$
- $4X + 6 = -7X + 39$
 $4X + 7X = 39 - 6$
 $11X = 33$
 $11X/11 = 33/11$
 $X = 3$
- $8Y - 12 = 3 + 3Y$
 $8Y - 3Y = 3 + 12$
 $5Y = 15$
 $5Y/5 = 15/5$
 $Y = 3$
- $X/6 = 5 - 2X$
 $6X/6 = 6(5 - 2X)$
 $X = 30 - 12X$
 $X + 12X = 30$
 $13X = 30$
 $13X/13 = 30/13$
 $X = 2.3$
- $X + Y = 18$
 $2X - 2Y = -44$

Multiply the first equation by 2:

$$2(X + Y) = 2(18)$$

Add the equations:

$$2X + 2Y + (2X - 2Y) = 36 - 44$$

$$4X = -8$$

$$X = -2$$

Using the first equation to solve for Y:

$$X + Y = 18$$

$$Y = 18 - X$$

$$Y = 18 - (-2) = 20$$

Check your answers on the other equation:

$$2X - 2Y = -44$$

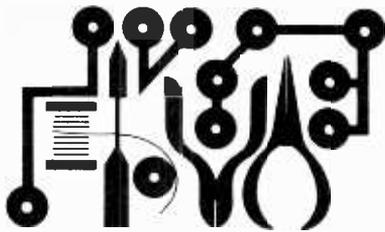
$$2(-2) - 2(20) = -44$$

$$-4 - 40 = -44$$

$$7. 2X + Y = 6$$

$$3X - 3Y = 0$$

(Continued on page 104)



Circuit Circus

By Charles D. Rakes

HEXFET APPLICATIONS

This month we're placing a power hexFET at center stage, performing in a number of interesting and useful tasks. The IRF511 N-channel power MOSFET is one of the least expensive of the hexFET devices that International Rectifier (IR) produces, and is available from at least two **Popular Electronics** advertisers: Digi-Key Electronics and Radio Shack.

The IRF511 has a maximum on-state resistance of 0.6 ohm, input/output capacitance of less than 150 picofarads (pF), a gate threshold voltage (voltage level needed to turn on the device) of between 2 and 4 volts, a maximum drain-to-source voltage of 60 volts, and a maximum drain current of 3 amperes. In addition, its maximum power dissipation is 20 watts, and it comes in the handy TO-220 plastic package.

Inverters, choppers, switching power-supplies, motor controls, audio amplifiers, and high-energy pulse circuits are but a few of the applications where that semiconductor device can be pressed into service. But enough about the unit's characteristics. Let's get to the point of this column—to teach as well as entertain.

Class A Amplifier. Our first act places the IRF511 (Q1) in a simple class-A audio-amplifier circuit. See Fig. 1. With zero gate bias applied, Q1 is like a

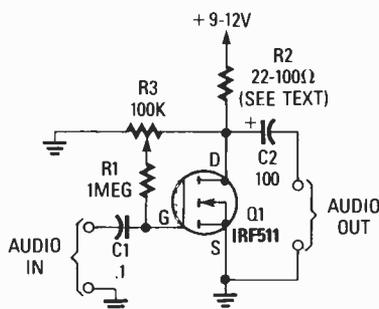


Fig. 1. In this circuit the IRF511 is configured as a class A amplifier. Ideally, for class-A operation, the voltage across Q1 and the load resistor should be equal.

PARTS LIST FOR THE CLASS A AMPLIFIER

Q1—IRF511 hexFET
 R1—1-megohm, 1/4-watt, 5% resistor
 R2—22-100-ohm, 1/4-watt, 5% resistor (see text)
 R3—100,000-ohm potentiometer
 C1—0.1-μF, ceramic-disc capacitor
 C2—100-μF, 25-WVDC, electrolytic capacitor
 Printed-circuit or perfboard materials, 9-12 volt power source, wire, solder, etc.

switch in the off state, so no current flows through the load resistor, R2.

Ideally speaking, the voltage across Q1 and the load resistor should be equal for class-A operation. A 100K potentiometer (R3) and a 1-megohm fixed resistor (R1) make up a simple adjustable gate-bias circuit. Place a voltmeter between the drain of Q1 and the circuit ground, and adjust R3 for a meter reading of half the power-supply voltage.

Almost any resistor value can be used for R2 as long as the maximum current and power ratings of the FET are not exceeded. A resistor value of between 22 and 100 ohms is a good choice for experimenting. At high currents, a suitable heat sink should be used.

Relay Controller. The second circuit, shown in Fig. 2, has the power FET (Q1) controlling a relay. With zero gate-bias applied, Q1 acts like an open switch, but when a DC voltage greater than 5 volts is applied to the input of the circuit, Q1 turns on, completing the relay circuit and thereby activating the relay coil.

PARTS LIST FOR THE RELAY CONTROLLER

Q1—IRF511 hexFET
 D1—1N4001 silicon rectifier diode
 R1—100,000-ohm, 1/4-watt, 5% resistor
 R2—1-megohm 1/4-watt, 5% resistor
 K1—12-volt DC relay
 Printed-circuit or perfboard materials, 12-volt power source, wire, solder, etc.

The input bias current required to turn on Q1 and operate the relay is less than 10 microamperes (μA), which is about 1/1,000,000 of the current required to bias the popular 2N3055 power transistor to operate the same relay.

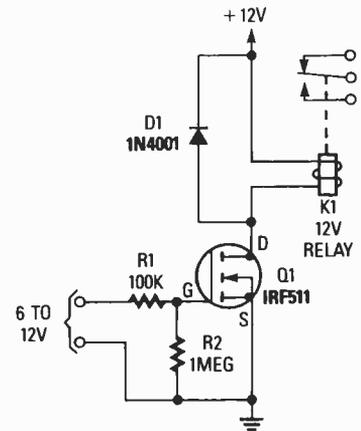


Fig. 2. With zero gate-bias applied, Q1 acts like an open switch, but when a DC voltage greater than 5 volts is applied to the input of the circuit, Q1 turns on, completing the relay circuit, and thereby activating the relay.

Proximity Switch. The next circuit (see Fig. 3) takes advantage of the ultra-high input impedance and power-handling capabilities of the FET to make a simple, but sensitive, proximity sensor and alarm-driver circuit.

A 3 × 3-inch piece of circuit board (or similar size metal object), which functions as the pick-up sensor, is connected to the gate of Q1. A 100-megohm resistor, R2, isolates Q1's gate from R1, allowing the input impedance to remain very high. If a 100-megohm

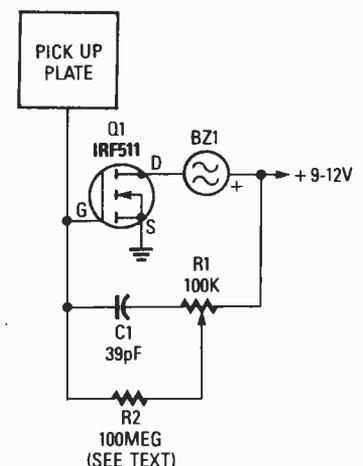


Fig. 3. The sensitivity of this Proximity Switch can be varied by adjusting R1. Note that R2 is specified as a 100-megohm unit, if that value cannot be located tie five 22-megohm resistors in series and use that combination for R2.

PARTS LIST FOR THE PROXIMITY SWITCH

Q1—IRF511 hexFET
 R1—100,000-ohm potentiometer
 R2—100-megohm, 1/4-watt, 5% resistor (see text)
 C1—34-pF ceramic-disc capacitor
 BZ1—piezo electric buzzer
 Printed-circuit or perfboard materials, enclosure, 9-12-volt power source, wire, solder, etc.

resistor cannot be located, just tie five 22-megohm resistors in series and use that combination for R2. In fact, R2 can be made even higher in value for added sensitivity.

Potentiometer R1 is adjusted to a point where the piezo buzzer just begins to sound off and then carefully backed off to the point where the sound ceases. Experimenting with the setting of R1 will help in obtaining the best sensitivity adjustment for the circuit. Resistor R1 may be set to a point where the pick-up must be contacted to set off the alarm sounder. A relay or other current-hungry component can take the place of the piezo sounder to control most any external circuit.

Lamp Flasher. The circuit in Fig. 4 is built around two power FET's, which are configured as a simple astable multivibrator to alternately switch the two lamps on and off. The R/C values given in the Parts List sets the flash rate to about 1/3 Hz. By varying either the resistor or capacitor values almost any

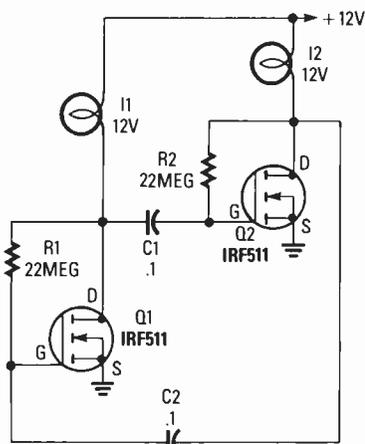


Fig. 4. In this circuit, two hexFETs are configured as a simple astable multivibrator to alternately switch the two lamps, I1 and I2, on and off.

flash rate can be obtained. Increase either C1 and C2, or R1 and R2, and the flash rate slows. Decrease them and the rate increases.

Unlike most semiconductor devices,

the power MOSFET can be paralleled, without special current-sharing components, to control larger load currents. That can be an important feature when the device is used to turn on incandescent lamps, because the lamp's cold resistance is much lower than the normal operating resistance.

A typical #1815 12- to 14-volt lamp measures 6 ohms cold. When 12 volts is applied, the initial current drawn is 2 amps. The same lamp, when operating at 12 volts, requires only 200 mA. The hot resistance figures out to be ten times its cold resistance, or 60 ohms. That tidbit should be considered when picking any semiconductor device to control an incandescent lamp.

PARTS LIST FOR THE LAMP FLASHER

Q1, Q2—IRF511 hexFET
 R1, R2—22-megohm, 1/4-watt, 5% resistor
 C1, C2—0.1- μ F, mylar capacitor
 I1, I2—12-volt incandescent lamp
 Printed-circuit or perfboard materials, 12-volt power source, wire, etc.

Audio Oscillator. The next circuit places the power FET in the output stage of an audio variable frequency oscillator (VFO) circuit (see Fig. 5). That simple VFO circuit can be used for audible-tone testing, driving someone nuts, or transformed into a simple electronic musical instrument. For instance, several might be wired parallel to each other with each tuned for different frequencies, with pushbutton switches added to control the power circuit, thereby producing a simple electronic organ.

Two gates, U1-a and U1-b (1/3 of a 4049 hex inverter), are connected in a VFO circuit. Components R1, R3, and C1 set the frequency range of the VFO.

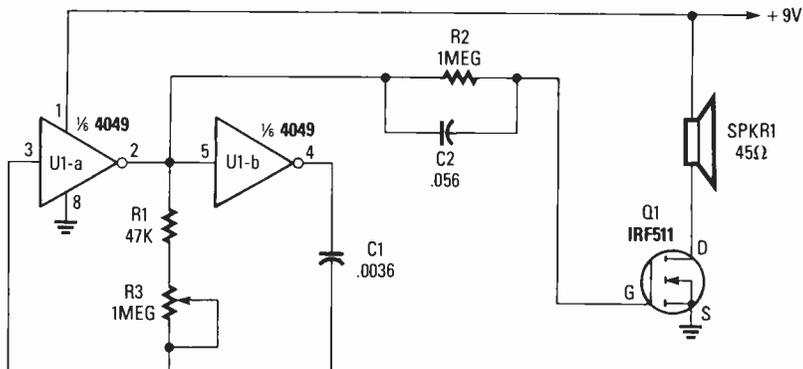


Fig. 5. This simple VFO circuit can be used for audible-tone testing, driving someone nuts or it can be transformed into a simple electronic musical instrument—an electronic organ, for example.

PARTS LIST FOR THE AUDIO OSCILLATOR

U1—4049 hex inverter, integrated circuit
 Q1—IRF511 hexFET
 R1—47,000-ohm, 1/4-watt, 5% resistor
 R2—1-megohm, 1/4-watt, 5% resistor
 R3—1-megohm potentiometer
 C1—.0036- μ F, mylar capacitor
 C2—.056- μ F, mylar capacitor
 SPKR1—45-ohm speaker (2 or 3 inch diameter)
 Printed-circuit or perfboard materials, enclosure, wire, solder, etc.

With the values given, the circuit's output can range from a few hundred hertz to over several thousand hertz by adjusting R3.

The simplest way to change the frequency range of the oscillator is to use different capacitance values for C1. A rotary switch, teamed up with a number of capacitors, can be used to select the desired frequency range.

Cassette Interface. In our next circuit (Fig. 6) two power FET's (Q1 and Q2) are used to form the basis of an interface circuit for attaching a cassette recorder to the phone line. If you're fed up with your answering machine, because the incoming tape always fills up with sales pitches so that when a really important message comes through, there's no more room, then this circuit could be for you. Of course your machine must be able to continue to operate when the incoming tape is full.

With the Interface circuit installed, place a long-play tape in your cassette recorder, press the record switch, and get all of the incoming messages. Or the circuit can become a 24-hour automatic secretary to record all incoming phone calls.

The circuit does not require a power supply because operating power is drawn from the telephone line itself.

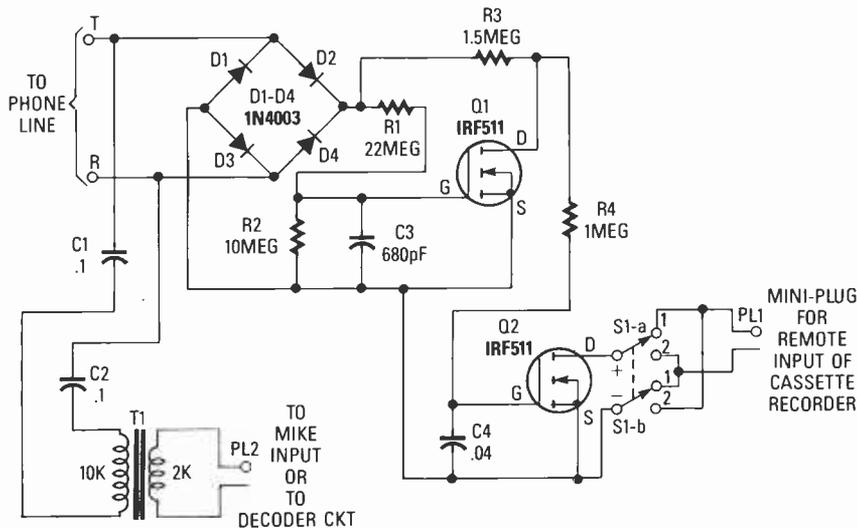


Fig. 6. The Cassette Interface does not require its own power supply, but instead rectifies a portion of the incoming audio signal to provide power for the circuit.

The incoming signal is fed across a bridge-rectifier circuit, consisting of diodes D1 through D4. If you are familiar with the operation of bridge rectifiers, you'll realize that the bridge ensures that no matter how the circuit is connected to the phone lines, the voltage at the junction of R1 and R3 will always be positive.

When the phone is on hook the voltage at the output of the bridge (at R1/R3 junction) is near 48 volts. That voltage is fed across a voltage divider consisting of R1 and R2. The voltage at the junction formed by R1 and R2 is fed to the gate of Q1, turning it on. That pulls the drain of Q1 low. Since the gate of Q2 is connected to the drain of Q1, the

bias applied to the gate of Q2 is low, holding it in the off state.

When the answering machine responds to a call or a phone is taken off hook, the voltage across the phone lines drops below 10 volts, causing Q1 to turn off. At that point, the voltage at Q1's drain rises, turning Q2 on. The remote input of the cassette is con-

PARTS LIST FOR THE SOUND-ACTIVATED SWITCH

SEMICONDUCTORS

U1—LF353 dual op-amp, integrated circuit
Q1—IRF511 hexFET
D1, D2—1N914 general-purpose silicon diode

RESISTORS

(All fixed resistors are 1/4-watt, 5% units.)

R1, R7—2200-ohm
R2, R3—10,000-ohm
R4, R9—1000-ohm
R5—100,000-ohm
R6—10,000-ohm potentiometer
R8, R11—220,000-ohm
R10—130-ohm
R12—1-megohm

CAPACITORS

C1, C3, C6—0.47- μ F, 16-WVDC, electrolytic
C2—47- μ F, 16-WVDC, electrolytic
C4, C5—0.1- μ F, 100-WVDC, ceramic disc

ADDITIONAL PARTS AND MATERIALS

MIC1—Electret condenser microphone
Perfboard material, enclosure, IC sockets, 9-volt battery and battery holder, wire, solder, hardware, etc.

PARTS LIST FOR THE CASSETTE INTERFACE

SEMICONDUCTORS

Q1, Q2—IRF511 hexFET
D1-D4—1N4003 silicon diode

RESISTORS

(All resistors are 1/4-watt, 5% units.)
R1—22-megohm
R2—10-megohm
R3—1.5-megohm
R4—1-megohm

CAPACITORS

C1, C2—0.1- μ F, mylar
C3—680-pF, ceramic disc
C4—0.04- μ F, mylar

ADDITIONAL PARTS AND MATERIALS

T1—miniature audio transformer (10K to 2K)
S1—DPDT toggle switch
PL1, PL2—See text
Printed-circuit or perfboard materials, modular telephone plug, enclosure, IC sockets, battery and battery holder, wire, solder, hardware, etc.

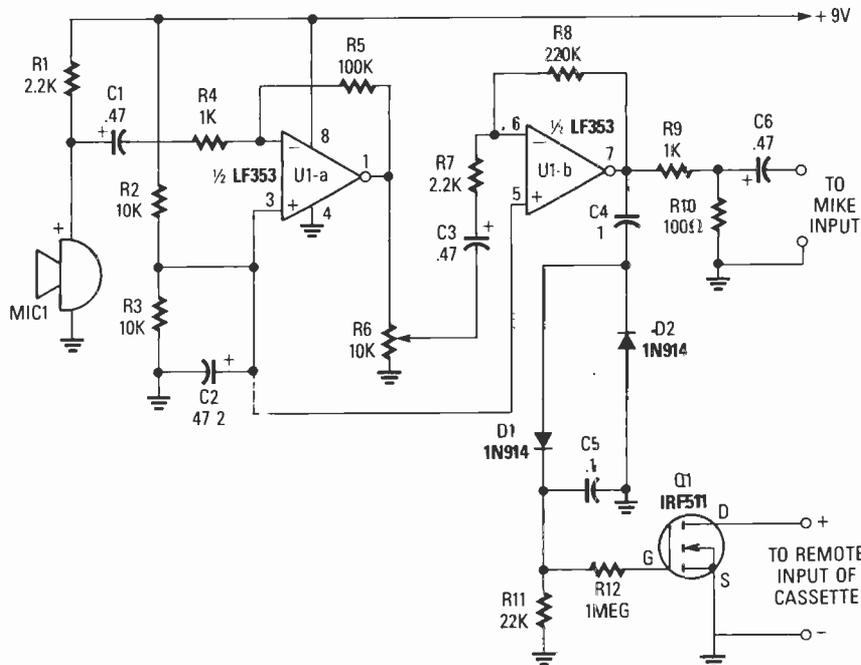


Fig. 7. The electret microphone MIC1 picks up the sound and feeds the signal to a two-stage amplifier circuit, consisting of U1-a and U1-b, the output of which is fed to a voltage-doubler circuit (made up of D1, D2, C4, and C5).

nected to Q2's drain and source through S1 and a miniature plug selected to mate with the remote input jack.

Switch S1 must be in a position so that the positive lead of the recorder's remote input connects (through switch position 1) to Q2's drain and the nega-

tive input to Q2's source. Switch S1 provides a convenient way to reverse the circuit's trigger output without having to unsolder and resolder leads. The phone's audio is coupled through C1, C2, and T1 to the microphone input of the cassette recorder.

(Continued on page 98)



Antique Radio

By Marc Ellis

CLEARING UP ANOTHER PHILCO "MYSTERY"

Back in the November, 1988 column, I asked for some help in identifying a mysterious-looking Philco device submitted by reader Larry Lovell. Housed in a scaled-down radio cabinet, bearing a gold Philco logo, its only operating control was a plastic telephone-style rotary dial.

The following month, I challenged the readers with a Philco "mystery" unit of my own: a small (about 5-inches tall), highly-chromed device that looked like a miniaturized version of a 1920's radio speaker. I had been able to identify the unit by thumbing through Morgan McMahon's well-known book *A Flick of the Switch*, and suggested that any sharp-eyed reader should be able to do the same.

The Readers Write! Since then, your letters have been pouring in, and it's all been fascinating. Some readers have sent in educated guesses about what those units had to be; others remembered using—or servicing—them in days gone by. Many people have taken the trouble to Xerox and send along schematics, service notes, advertisements, and other types of documentation.

Last month, I devoted the entire column to going over the information I received about the first item—a wireless remote control for a Philco receiver, which had been appropriately named by the manufacturer "The Philco Mystery Control." This month, let's tackle the second item.

First, credit for the guesses! The most creative ones came from two readers—both, as it happens, from New York State. Ron Laguardia thought the device might be a speaker for a police car siren or PA system. But Bob Schaumleffel had a different slant; to him, it looked like a cigarette lighter.

Less colorful, but correct, guesses were received from Andrew Mooradian (Winchester, MA), George Rutkay



No longer a mystery, this is the little speaker-mike that caused all the comment!

(Brampton, Ontario, Canada), Clyde Clymer (Weiser, ID), Michael Johnson (St. Gabriel, LA) and Randy Rago (Brooklyn, NY)—all of whom felt that the unit had to be a microphone.

The Living Room Wonder. Now it seems that that type of Philco microphone had at least two different applications: the one I'd already identified from Morgan McMahon's book—and another previously unknown to me. Reader Raymond Ives (Cameron Mills, NY) explains the first application in a letter containing some reminiscences from his teenage years."

Says Raymond, "The Philco *Wotizzit* pictured in your December column brought me back to about 1940. I was just then becoming a teenager. Two of the most memorable items in my parents' house were the upright piano and the Philco.

"The piano, though memorable, was unremarkable. But the Philco, a stately console, was then a modern-day wonder! In addition to the usual multi-band reception, it also featured automatic record changing and *light-beam* sound transmission from record to amplifier.

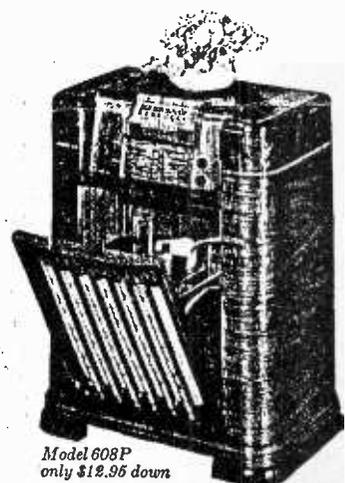
"A constant light source was directed towards a mirror that was

mounted on the stylus assembly. The reflected light, modulated by the motion of the stylus, was captured by a photo-sensitive device and the resultant signal amplified by the system.

"That feature effectively reduced hiss and scratch. Unfortunately it also effectively reduced many highs and much brilliance. However, that fit in beautifully with the boomy sound, which was 'cool' during that era.

"Mounted on the turntable was another *tone-arm*. This arm was mechanically guided and its stylus was a steel cutter designed to record an audio track on a lacquer coated aluminum disk. The home entertainment center was also a recorder! And that brings us back to the Philco *wotizzit*. Resting on top of the console was a brown enameled, round (about 4.5 inches in diameter) device with a flock-covered grill of metal window screening. The speaker inside was really the dynamic microphone for our home entertainment center with the built-in recorder. Thanks for jogging my memory!"

A number of other people shared their personal memories of that Philco console, including Victor Manno (New York, NY), James B. Salinia (San Antonio, TX), Gary Kendall (Grafton, WI) and Mark S. Cockrill (Seattle, WA). Others who were able to identify the Philco console were Milivoj Rudan (Stoney Creek, Ont., Canada), Jerry L. Johnson (of Radio Reproductions, Ft. Worth, TX)—who included a Xerox of



Model 608P
only \$12.95 down

See and Hear Them Now at Your Nearest Philco Dealer

Reader Jerry L. Johnson, sent in this photocopy of an advertisement for the Zenith 41-608 console. The model illustrated here didn't include the recording option.



Can anyone figure out Dick Spratley's mystery project? Here's a hint: The device at the left is a crystal radio receiver.

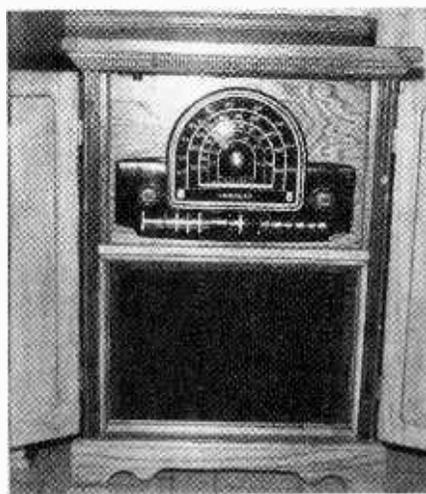
an original ad for the console—Larry Baker (San Angelo, TX), Reno Ruggere (Shillington, PA), and Bill Johnson (Atlanta, GA).

Larry also correctly identified the "Philco Mystery Control" for us.

Walter Eismann identified the microphone and sent along a shot of the one in his collection. He found his example in much the same way I found mine—by carefully scrutinizing the contents of boxes of obscure junk at a local flea market. Walt has an extensive collection of antique radio items, and offers to correspond with readers having questions about the hobby, provided that they include an S.A.S.E. Write him at 1659 W. 6th Ave., Eugene, OR 97402.

Finally, let's have a round of applause for the four intrepid sleuths who followed up my hint and located the Philco Model 41-608 Radio-Phono-Recorder console (9 tubes, 1941) on page 133 of *A Flick Of The Switch*. If you have that book, turn to page 133 now, and you'll see what Richard Spratley (Chesapeake, WA), Andy Czymbor (Burt, MI), Jack Beltz (Bartlett, IL) and James Salinia (see above) have already discovered. The shadowy shape sitting on top of the console is obviously the silhouette of our Philco microphone, and is what first gave me the clue to its true function.

The Philco Phone. Along with all of the letters telling me about the Philco home-recording console came a few that surprised me. They advised me of yet another product using that microphone—one I hadn't heard of. The first letter came from George A. Fathauer, the "son" half of the father-and-son



This is Randy Eppmeh's Crosley Model 148CP. Randy designed and crafted the cabinet himself.

team that operates Antique Radio Supply of Tempe, Arizona.

George was kind enough to send along a good Xerox of an advertising brochure for the Philco Phone, a basic intercom system for the home or small office. The master station for that little system looked like a table model AC/DC radio; the remote units looked like—you guessed it—our little microphone!

Ben Tillson (Brewster, MA) also remembers those microphones (or speaker-mikes, as they must have been in this application) as remote units for the Philco intercom. And R.J. Wopshall (Toledo, OH) has a complete working system. R.J. says that his system has two styles of remote units: chrome-plated ones with locking, on/off slide-type, call switches; and brown-painted ones with non-locking, spring-loaded, call switches.

He theorizes that the chrome-plated

remotes were for use in the kitchen or bath. But I'm wondering if the units were made with different finishes so that a person could quickly identify which ones had the locking switches and which had the spring-loaded ones. And perhaps the remotes with locking switches could be left in permanent "listen" mode for monitoring nurseries or sickrooms.

Since my own unit is chrome-plated and has a locking slide switch, I'm beginning to wonder if it wasn't manufactured as an intercom remote rather than a recording microphone. You'll recall that Ray Ives, whose letter I quoted earlier, spoke of the microphone for his family's recording unit as being "brown painted."

Maybe somebody will write in and shed more light on the subject. And speaking of light, are there any readers in the audience who can send more information about the "beam of light" playback system mentioned in Ray's letter? It would certainly be an interesting subject for a column. In fact, if anyone living in the metropolitan Chicago area has one of those sets and would be willing for me to come over and take some pictures of it, please drop me a line!

Before leaving the subject of the little Philco microphone, I'd like to acknowledge a postcard from Hal Leary (Montrose, CO). Hal recalls that Philco sold the microphone as an accessory for attachment to any radio receiver so that you could use the set as a PA system and be the life of the party. So far, though, he's the only person who has reported on that particular use for the product. Does anyone know more about it?

Mysteries Old and New. Two readers sent their comments about the "Philco Mystery Control" a little too late to be included in last month's column. Raymond Musick (Oklahoma City, OK) remembers seeing a Wichita, Kansas department-store salesman, stationed on the sidewalk and armed with a control unit, change stations on a radio displayed in one of the store windows. Quite impressive to the passers-by! Eric Taylor (1365 10th Ave., #6, San Francisco, CA 94122) sent a copy of a very complete discussion of the Philco control as printed in *Audel's New Elec-*

(Continued on page 100)



Computer Bits

By Jeff Holtzman

HARD-DISK DRIVES

For the past couple of months, we've been discussing assembling your own PC from scratch; much of the discussion is also applicable to those upgrading their systems. So far we've covered the CPU, video system, and floppy-disk drives. Now let's talk about hard-disk drives. That's an important topic, because other than the CPU, nothing affects overall system performance as much as the hard-disk drive.

The Basics. There are four things to consider when buying a hard disk: capacity, access time, type of drive, and interface. Drives commonly sold these days come with capacities starting at 20 megabytes (MB) and ranging through 30, 40, 60, 80, 100, and more. A 20MB drive may satisfy you for awhile, but if you see yourself getting intimately involved with computers in the next few years, 40MB or 60MB should be your minimum.

Access time provides one indication of how well a drive performs; the term refers to the average amount of time it takes the read/write head to move from any one track on the disk to any other. The lower the access time, the better the performance, and the higher the price. Access time is independent of drive type (see below).

Inexpensive drives (ST-225) have access times of about 65 ms; average drives (ST-251), about 40 ms; good drives (ST-251-1), about 30 ms. Below 30 ms, prices escalate rapidly.

The type of drive also affects performance directly; it is determined by how information is stored on a disk. Information may be recorded on a disk drive in many ways, but two formats are popular for personal computers: MFM (Modified Frequency Modulation) and 2,7 RLL (Run-Length Limited). The technical differences are beyond the scope of this discussion, but practically speaking, an RLL drive holds 50% more information than an

MFM drive, and that information can flow to and from the drive 50% faster.

Some people buy MFM drives (which are somewhat cheaper) and use them in the high-density RLL mode, but doing so is risky, because the magnetic media on which information is stored may not be able to retain that information over a long period of time. In addition, running an MFM drive in RLL mode usually invalidates the manufacturer's warranty.

Different types of controllers are required for MFM and RLL operation; an RLL controller generally costs 33%-50% more than a standard MFM controller. Early RLL technology for PC's was unreliable, but manufacturers appear to have solved the problems.

In addition, two new types of drive/interface combinations are becoming increasingly popular, especially for high-end systems (network file servers, for example): SCSI (Small Computer System Interface) and ESDI (Enhanced Small Device Interface). ESDI drives cost too much for personal use, but SCSI prices have recently dropped to an affordable level. JDR is one of the

few mail-order vendors selling SCSI drives and adapters to end users. (Thanks to JDR for the loan of one for testing.)

An SCSI drive has the controller built into the drive itself; a small and inexpensive (\$50) host adapter is all that is required to attach an SCSI drive to a PC. SCSI offers some interesting possibilities for growth. For example, the SCSI specification allows you to "daisy-chain" as many as eight devices along the same cable.

In addition, because the SCSI interface is not tied to a particular bus structure, you should be able to unplug an SCSI device from one computer (a PC) and plug it into another (a Macintosh). Of course, you'd need appropriate software for translating between different file formats. That's not as far-fetched as it sounds; Irwin Magnetics has designed an SCSI-interface tape-backup system that allows IBM and Macintosh users to exchange tapes.

Hardware. Now let's look at some real hardware. In what follows, I'll discuss Seagate's line of drives and controllers; comparable devices are also available from Miniscribe, Adaptec, and others.

The most popular drive for 8088-based machines is the ST-225. It is an MFM drive with a capacity of 20MB and a measurable access time of 65 ms. Closely related is the ST-238, which is basically the same drive certified for RLL operation. That means it still has a 65 ms access time, but it can hold 30MB of information, and its data

Data Transfer Rate (KB/sec) for Several Popular Disk Drives at Various Interleave Factors

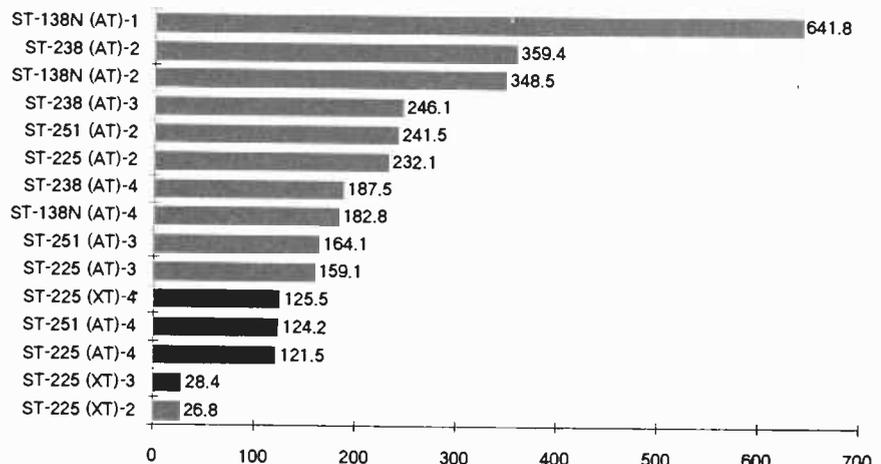


Fig. 1. Shown here is a performance comparison of several popular drives. What's being measured is the raw-data transfer rate—the fastest rate at which a particular combination of drive, controller, and system bus can operate.

transfer rate (DTR) is 50% faster than the ST-225.

Next up is the ST-251, a popular MFM drive for AT compatibles. The ST-251 has a 40 ms access time and a 40MB capacity. The ST-251-1 also holds 40MB, but has a 28 ms access time. The ST-277 is the RLL version of the ST-251; it holds 60MB with an access time of 40 ms.

SCSI versions of most of those drives are also available. They generally offer the same capacities and the same access times; depending on how they're formatted, however, they can offer vastly improved data transfer rates, as we'll see shortly.

Table 1 summarizes the major characteristics of the drives we've been discussing, and includes approximate prices that were current around the first of the year.

With regard to cost: There's a huge glut of drives on the market, so there's never been a better time to buy. The reason is simply that Seagate (which recently laid off 25% of its work force) and other companies over-produced during 1988, so prices have been dropping on a monthly basis.

For example, I bought an ST-251 and controller about a year ago for \$100 more than what it costs now. If I were buying now, I'd probably go for the ST-277N. Whatever you decide on, be sure to shop around; some vendors respond quicker than others to changing supply/demand situations.

How They Rate. Figure 1 shows performance comparisons of several popular drives. What's being measured is the raw-data transfer rate—the fastest rate at which a particular combination of drive, controller, and system bus can operate. In actual use under DOS, the differences may not be quite so pronounced, depending on the type of operation.

Generally speaking, sequential operations (program loading and file copying) will benefit more from high data-transfer rates than random operations (updating a database), assuming you keep your disk unfragmented (all sectors of a file located contiguously). I use a \$60 program called *Vopt*, made by Golden Bow Systems for that purpose. (Tell 'em I sent you.)

For purposes of comparison, I tested an ST-225 in both an XT and an AT compatible; the other drives were all tested in the AT (an AST Premium/286 running at 10 MHz). Each drive was test-

TABLE 1—DISK DRIVE CHARACTERISTICS AND PRICES

Drive	Type	Capacity	Access Time	Drive Price	Package Price
ST-225	MFM	20 MB	65 ms	\$225	\$270
ST-238	RLL	30 MB	65 ms	\$250	\$300
ST-251	MFM	40 MB	40 ms	\$430	\$470
ST-251-1	MFM	40 MB	30 ms	\$530	\$610
ST-277	RLL	60 MB	40 ms	\$500	\$550
ST-138N	*RLL	30 MB	40 ms	\$400	\$450
ST-277N	*RLL	60 MB	40 ms	\$550	\$600

*RLL drive with SCSI interface

ed with several different interleave factors (IF). The IF states how far apart logically adjacent sectors are located on the disk physically.

For example, with an IF of 1, sector one is physically located next to sector two, etc. With an IF of two, one sector appears between sectors one and two; with an IF of three, two sectors, etc. Sectors are skipped in that fashion to allow the CPU time to digest information from the disk controller.

In general, the lower the IF, the better the performance. With an IF that is too low, however, performance can suffer tremendously, because instead of lapping up each sector as it passes beneath the read/write head, the disk controller must wait an entire revolution. On the other hand, with an IF that is too high, the CPU dawdles while waiting for the interleaved sectors to go by. In general, faster machines can run with lower IF's, another reason to avoid an 8088-based machine. It takes some experimentation to determine the optimal interleave.

In Fig. 1, each entry shows the drive type (ST-138N), machine in which it

was tested (AT), and the IF (-1). First examine the numbers for the ST-225 in the XT. At interleaves of 2 and 3, the CPU simply can't keep up: the DTR is under 30 KB/sec. At the optimal IF for that machine (4), DTR is about four times as great—about 125.

Then look what happened when that same drive was formatted on the AST. At the same IF (4), its performance was nearly identical. Decreasing the IF to 3 increased the DTR by about 25%. At the optimal IF (2), performance nearly doubled (232) compared with the XT's optimal rate.

Now look at the results for the ST-238 (RLL). As expected, at the correct interleave (2), its DTR (360) is about 50% greater than the ST-225's (232). It's also about 50% faster than the ST-251's (240), and that's an interesting point.

The ST-251 costs about 70% more than the ST-238; for the extra \$180 you get only another 10MB of storage and 60% faster average access time. However, even though the read/write head can get to the information on the disk faster, that information is actually transferred to memory faster by the ST-238, assuming a well-packed disk. So, a pair of ST-238's (which will run off a single controller) costs little more than a single ST-251, provides more storage, and better overall performance (on an unfragmented disk).

Last, look at the figures for the ST-138N, an RLL drive with an SCSI interface. At sub-optimal interleaves, performance is at best comparable to the ST-238. But at an IF of 1, performance soars to 640 KB/sec.—that's flying!

Buying and Setting Up. To determine the optimal interleave for your system, you'll have to perform a low-level format at each possible IF and then measure the DTR. You can measure the DTR with CORETEST.EXE, a program developed by disk manufacturer Core International. It's available on many

(Continued on page 106)

MANUFACTURERS AND DISTRIBUTORS

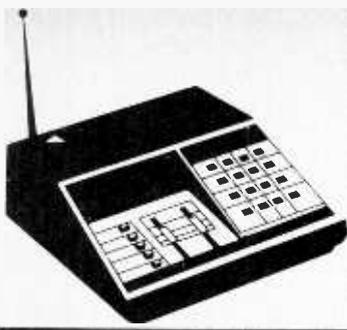
Golden Bow Systems
2870 5th Avenue
San Diego, CA 92103
Tel. 800/284-3269; 619/298-9950

Ontrack Computer Systems, Inc.
6222 Bury Drive
Eden Prairie, MN 55344-9957
Tel. 800/752-1333; 612/937-1107.

Storage Dimensions
981 University Avenue
Los Gatos, CA 95030
Tel. 408/879-0300.

Seagate Technology, Inc.
920 Disc Drive
Scotts Valley, CA 95066-4544
Tel. 408/438-6550.

JDR Microdevices
110 Knowles Drive
Los Gatos, CA 95030
Tel. 800/538-5000; 408/866-6200.



Scanner Scene

By Marc Saxon

A ROCKY START

The proposed \$5.7-million police/fire-radio system planned for Denver, Colorado, has been replaced by a \$3.4-million computerized system. That was a temporary step so that other city agencies might draw up plans to hook into the larger system when it is built. The new 800-MHz system, which is part of the computerized system, recently went into operation and is a vast improvement over the old system—which long ago became overloaded and outdated.

Meanwhile, the handheld transceivers (put into use by the Los Angeles Fire Department (at a cost of about \$2500 each) have been hailed as a huge success. Those 800-MHz units are now in general use throughout the entire agency.

One of the biggest advantages of those expensive little sets is that the 800-MHz frequencies are better for fighting blazes in high-rise buildings than the older, low-band radios that the agency had been using. Although the 30-MHz units may have a better range than those operating at 800 MHz, their signals have a difficult time getting out of confined areas, such as tall buildings. Whereas, the 800-MHz signals penetrate walls, concrete, steel mesh, and all of the other materials used for high-rise building construction.

Incidentally, that's one reason why cellular phones, which also utilize 800-MHz frequencies, work well inside office buildings and vehicles.

On the Market. You can swing into spring with Radio Shack's deluxe handheld scanner, which goes under the name *Realistic PRO-34*. With the exception of a few gaps, it covers from 30 to 960 MHz, and it's keyboard programmable for those 32,000+ different frequencies.

Its complete frequency coverage is from 30 to 54 MHz, 108 to 174 MHz, 380 to 512 MHz, 806 to 824 MHz, 851 to 869



Realistic's PRO-34 deluxe handheld scanner covers from 30 to 960 MHz, is keyboard programmable, and features a 200-channel scanning memory, and more.

MHz, and 896 to 960 MHz. Combine that coverage with a 200-channel scanning memory and that spells: Wow, with a capital W! The 200 channels are broken up into 10 groups of 20 frequencies. That gives you the option of putting police frequencies (for instance) in frequency-group 1, federal frequencies in group 2, aeronautic frequencies in group 3, etc., to be able to quickly select only those categories of stations that you wish to hear at any given time.

Other features of the PRO-34 include search/scan with easy transfer of any amazing frequency discoveries into the unit's memory, 8 or 4 channels-per-second scanning or searching, switchable 2-second delay, individual lockouts, keyboard lock, LCD display, belt clip, rubberized antenna, and selectable priority channel.

The Realistic PRO-34 measures about 7 x 3 x 2 inches, and runs on six

"AA" batteries. You can use rechargeable batteries (although you'll have to supply your own charging unit since one isn't supplied with the PRO-34).

We found the Realistic PRO-34 proved to be easy to use, well designed, and an excellent performer. The scanner sells for \$329.95 at all Radio Shack stores. You may have noticed that cellular coverage was omitted from the scanner. It can be restored with some minor effort. If you want that information, please send me a self-addressed, stamped, envelope and request the PRO-34 cellular modification.

Speaking of modifications to Realistic scanners, I can (upon request accompanied by a self-addressed, stamped, envelope) also provide information on increasing the number of channels in the PRO-2004 from 300 channels to 400 channels.

Readers Write. Willie Randall drives an 18-wheeler out of Kansas City and says that he has always wondered if those ICC (Interstate Commerce Commission) units he comes across on the highways have two-way communications. If so, he wonders what frequency they use because he'd like to hear what they're saying about the truckers. Willie thinks they have CB radios to listen to the truckers, but he suspects that they have their own VHF or UHF radios, too.

You've got the right idea, Willie! If they're listening to you, listen back at them! We have heard some ICC communications on 409.20 MHz. If any of you out there in reader land knows of any additional channels, pass 'em along to us and we'll run them in this column.

A constant stream of letters and cards from many readers always asks where to get scanner books and frequency guides. We'd definitely suggest asking for a free catalog from CRB Research Books, Inc., PO Box 56-GP, Commack, NY 11725. They have a large selection of popular and hard-to-find shortwave books and directories. That includes many specialty directories for monitoring federal, car phone, aeronautic, railroad, and other especially interesting stations.

P.M.L., of Natchez, MS, says that he knows that it is recommended that lightning protection be added to high frequency (shortwave) antennas, but he wonders if that also means VHF

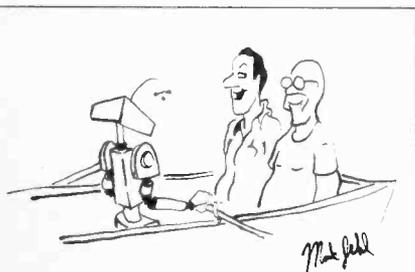
scanner antennas. We'd say a most emphatic yes. Thor (the God of Thunder) either doesn't know or care about the frequency coverage of the antenna he selects for a jolt. Lightning protection is so important that no outdoor antenna should be left without it.

S. DeSimone, of Los Angeles, wonders what it means when he hears stations on his scanner sending Morse code. He says that about every half hour or so, some stations that mostly transmit two-way voice communications, send out about 5 seconds of CW. We have also heard those transmissions, which are nothing more mysterious than an automatic station-identification transmission capability that some stations have installed at their bases. The CW consists of the station's FCC call sign sent once or twice.

Boris V., of Brooklyn, NY, says that he copies many taxi dispatchers in the band between 152.27 MHz and 152.45 MHz, but he can't seem to hear the taxi's replying to the dispatchers. That's because taxis operate between 157.53 MHz and 157.71 MHz, and are seldom repeated by the base stations operating on 152 MHz.

Whether the mobile units aren't repeated through the base so as to keep the fourteen 152-MHz taxi-dispatching channels as quiet as possible, or to prevent the drivers from kidding around with one another over the air, isn't known. The result is that if you want to copy both sides of the contact, you're going to have to monitor the 152 and 157 MHz channels.

Alas, we've once again run out of space, but be sure to catch us again next month, when we'll cover some more scanner-related topics. But in the meantime, if you have any tips, suggestions, comments, or questions, write to *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. Hope to hear from you soon! ■



"How do you like my row-bot?"

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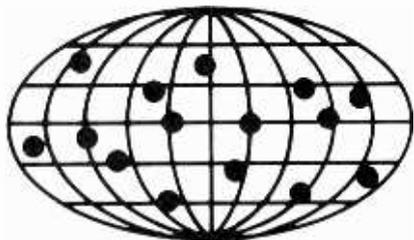


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DX Listening

By Don Jensen

A NEW FACE FOR THE BBC

The *British Broadcasting Corporation* finally got wise to what shortwave listeners have been whispering quietly for quite some time: "Auntie Beeb" (as the BBC is quaintly referred to) was showing her age.

The venerable English-language broadcasts of the BBC, currently known as the World Service, have long been recognized as a class act in international broadcasting. What London did on shortwave, it did—and continues to do—very well, indeed. But it was sounding stodgy and old-fashioned. So the shortwave service has overhauled its programming, particularly the news and public-affairs broadcasts, which for 58 years have been the most prestigious in the world.

There has been, for all those years, good reason for the BBC's reputation as the premier news broadcaster. The news from London was thorough and accurate. The BBC jealously guarded its image as an unbiased reporter. In recent years, it wasn't so much the content that was beginning to turn off listeners, but the style.

Last year, the annual shortwave-listener's guide, *Passport To World Band Radio*, in its pick of the 10 best international programs, said it publicly: "The BBC World Service does not have the best international-news broadcast on world-band radio!" *Passport* awarded that honor to *Radio Canada International's* (RCI) 90-minute daily duo, the "World at Six" and "As It Happens."

In London, officials also recognized, says John Tusa—managing director of the World Service—that aspects of the programming had been "verging on the pompous."

Traditionalists, though, need not worry that suddenly the BBC will sound like an AM "rocker." The Big Ben chimes will remain, the cricket scores,

and the BBC's mellow-sounding announcers, reassuring listeners on the hour that indeed "This is London..."

But there are changes, many of them in place since late last fall. The most apparent to longtime SWL's was the opening of the nearly 50-year-old "Radio Newsreel," a 15-minute in-depth newscast that has been must listening for news "junkies" since the WWII days.

Now it's called, simply "Newsreel." And gone is the longtime introduction, a rousing brass-band march (Imperial Echoes) that prompted images of an empire upon which the sun, supposedly, never set. Today's version of the theme is played on a synthesizer.

Announcers? Well, it's something of a touchy subject, since—as says Jocelyn Hay, chairman of a pressure group called Voice of the Listener—"correct pronunciation is one of the things that have made British broadcasting the best in the world."

Hay's group, and others, insist that the BBC sound must never degenerate

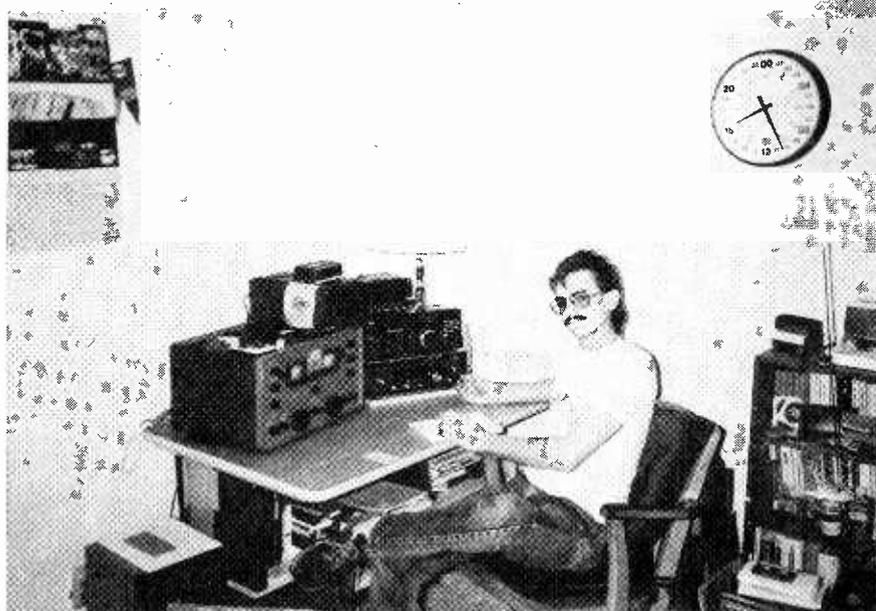
into the more casual speech of the BBC's home networks. And it won't, Tusa vows. But gradually SWL's may expect to hear more of the voice inflections of the middle-of-the-road educated England than the traditional upper-class, clipped, slightly nasal tones.

The clearest indication that perhaps Radio Canada International's "News at Six" and "As It Happens" have found a very listenable and informative approach, is the BBC World Service's competitive new "Newshour," airing at 2200 UTC.

The 60-minute news show begins with the World News and reports from BBC correspondents worldwide. That's followed by a detailed background to the major stories. For listeners who can't stay tuned for the entire hour, there is a brief summary on the half hour, plus highlighted main points elsewhere in the program.

Being aired live during the late evening in Britain, there is coverage of just-ended European sports events. Also included are closing results from the London and New York financial markets.

Another new program is *Mediawatch*, which the BBC says reports "the worldwide developments in this buoyant, boisterous, brash industry." What does that mean? For one thing, it offers a picture of what's new in communications technology. For another, it highlights what editors—the "gatekeepers" who decide what will be



Florida DX'er Russell Scotka fine-tunes automobile engines during his daytime job. In his off hours, Russ tunes one or more of his receivers to Latin American signals, both on shortwave and AM medium wave.

*Credits: Rufus Jordan, PA; Edward Kusalik, Alberta, Canada; Rich D'Angelo, PA; Kirk Allen, OK; North American SW Association, 45 Wildflower Rd., Levittown, PA 19057).

communicated to the public—are thinking and saying.

"With Good Reason" is a new discussion program, featuring three informed speakers; a host; and some topical questions on the arts, politics, education, world events, or just life in general. It airs Sunday and Monday.

Another Sunday news program is "Worldbrief", which is a summary of the most important stories of the preceding seven days. In addition to political events, it surveys sports and financial news of the past week, plus weather trends, pop music, and books.

And the BBC has high hopes for its new "Megamix" show, broadcast Tuesdays at 0030, 0830 and 2130 UTC, and aimed specifically at a younger audience. It will include music, of course, including—surprise—heavy-metal rock music. But "Megamix" is more, says the BBC, than just pops. It reflects the concerns of young people today, their fashions, crazes, health, hobbies, and their future.

Says Tusa, "It's really communicating with young people. They are setting the tone."

Together, those programs, and the rest of the changes in the planning stages, will make ol' Auntie Beeb more like "today's Britan," Tusa notes.

The question that remains to be answered is, how will those changes in BBC broadcasting go over with the World Service's 25-million English-speaking listeners?

Where and When. The BBC's World Service operates on numerous shortwave frequencies around the clock, using transmitters in the United Kingdom and relay stations in a number of overseas spots, including Ascension Island in the South Atlantic; on the island of Antigua in the West Indies; Sackville, New Brunswick, and Canada, which are most commonly heard in North America.

Here is a partial listing of the BBC's English schedule, which may be the best bets for tuning in those programs: 5,975 kHz, 2100 to 0600; 6,175 kHz, 2300 to 0400; 9,915 kHz, 2200 to 0400; 12,095 kHz, 1200 to 2400; 15,260 kHz, 2000 to 0200; 17,760 kHz, 2000 to 2100; 21,710 kHz, 1200 to 1600; 25,750 kHz, 1100 to 1400 UTC.

Feedback. As always, your letters, queries and information about your shortwave loggings are sought for this

column. Write to *DX Listening*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

And remember too, that Confucius say: "Picture is worth thousand words!" So send along your photos.

From the mailbag this month I have a note from a new reader, Albert Poulos, Los Angeles, CA, who says:

"I emigrated from Greece 25-years ago. I've always thought that I would again like to hear the broadcasts from my homeland, but I know nothing about radio. I saw your articles in this magazine and hope you can help."

Glad you wrote, Albert! For you, and others who may be just becoming aware of shortwave radio and are interested in hearing broadcasts in the languages of your homelands, there's a new book that should prove useful.

Voices From Home, subtitled, *How to Tune in Radio Programs from the Land you Left Behind*, by Gerry Dexter, is published by Tiare Publications. It begins with an introduction for those who, as yet, have little information about shortwave, and leads the reader through choosing a radio receiver, to actually tuning in those voices from home. It is available for \$11 postpaid, in the U.S., From Tiare Publications, PO Box 4993, Lake Geneva, WI 53147.

Down the Dial. Each month we take a look at what SWL's are hearing on the shortwave bands. Here, with times listed in UTC (Universal Coordinated Time, equivalent to EST + 5, CST + 6, MST + 7, and PST + 8), and frequencies in kilohertz, are loggings you can look for too:

Belgium—6,215 kHz. *World Mission Radio* (WRM) is a religious organization based in Belgium that leases air time from the unlicensed shipboard station, *Radio Caroline International*. That seagoing shortwave operation is located in international waters off the coast of England. Try for it at about 0730 UTC.

Bulgaria—7,670 kHz. *Radio Sofia* is a fairly common shortwave catch. More difficult to log is the Bulgarian shortwave home service from Stolnik, which sometimes can be heard on this frequency at around 0330 UTC, with popular Bulgarian melodies.

Mongolia—9,615 kHz. *Radio Ulan Bator* (RUB) from Mongolia is a very nice bit of DX to log on this frequency at, say, around 1130 to 1200 UTC. You might also look for their parallel frequency of 12,015 kHz. ■

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MAY 1989



Ham Radio

By Joseph J. Carr, K4IPV

RESURRECTING AN OLD TRANSMITTER

In the December 1988 issue of **Popular Electronics**, Larry Lisle (K9KZT) took us down nostalgia lane with his article "Those Indestructible Novice Transmitters." Having been first licensed when those war horses were featured in the then-current catalogues, and priced only painfully within the reach of a kid with a paper route, I owned several of the models Larry pictured.

Equipment like the Johnson Adventurer were among my first transmitters. The *DX-100* was, as Larry mentioned, one of the best bargains; although if memory serves, the *DX-100B* was the better of that series transmitters. Not mentioned in the Lisle article, incidentally, was a clunker made by Barker & Williamson—the *Model 5100B*. That unit was in the same power class as the Heathkit *DX-100*, but was of heavier construction. I've recently seen a couple of 5100B's on sale at hamfests. Also left out were the SSB rigs of that era. Models like the Heath *HW-100*, *HW-101*, and *SB-100*-series are easily obtained.

This year's hamfest season is just beginning, and that means low-cost radio "gold" is awaiting you. The supposed "indestructibility" of those old transmitters is witnessed by the fact that so many of them are still around. For instance, at last year's Gaithersberg hamfest, I saw a dozen or more Johnson Ranger transmitters, including one tailgater who was offering two of them for \$150.

I once ran into a chap who worked for a missionary radio outfit in the third world. Because commercial transmitters are so expensive, they found it economical to scour hamfests for usable AM rigs in the 50- to 250-watt class and then convert them to medium-wave broadcasting frequencies between the 80- and 40-meter ham bands (those bands are used for local and regional broadcasting around the world, even if not in the USA). They

found it cheaper to place small transmitters in small towns than to attempt covering an entire region with a large rig. The Johnson *Viking II* was particularly desirable because it tuned 3 to 30 MHz, using a roller inductor.

But despite their longevity, those "golden-olde" transmitters are not indestructible in any sense of the word. In this month's column, we will discuss what to look for, and how to resurrect a long-neglected transmitter.

Look Before You Leap. First, unless the dollar investment is too small to make investigation worthwhile, take the covers off the rig and inspect the innards. Look for missing shields. (Those early rigs were often well-shielded against TVI radiation.) For instance, a Heathkit *Model DX-60B* that I came across had the RF-deck cover and bottom cover missing. Those covers are merely flat aluminum plates, and new ones can be fashioned from hardware-store sheet aluminum (use the perforated type to vent the heat while retaining the RF).

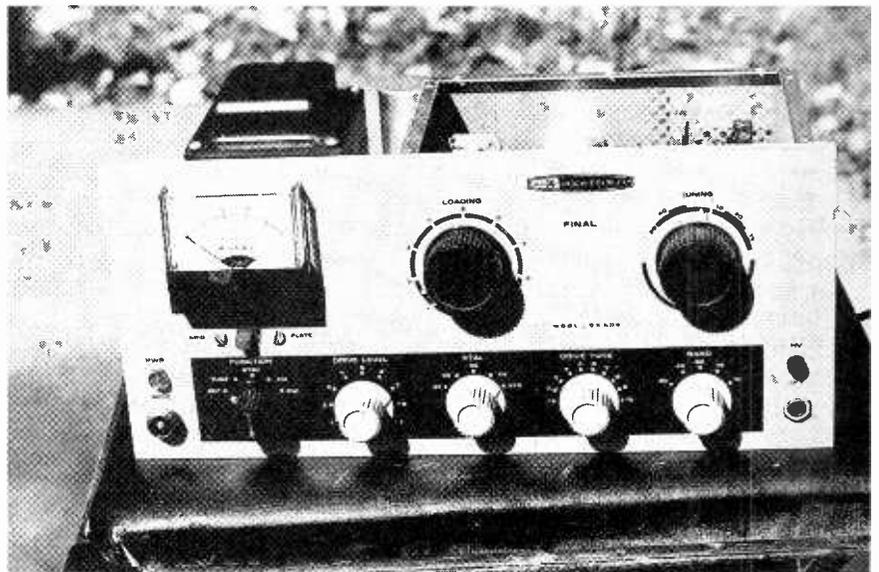
Also look at the power transformer, especially on the underside of the chassis. Take a sniff to see if you can detect the characteristic acrid odor of burnt tar, which would indicate that the transformer is shorted.

Then operate all of the controls in order to detect roughness or snagging operation. That could indicate that a variable capacitor is bent or that a potentiometer has been burnt. Of course, none of those defects is necessarily fatal, but it might give some indication as to which one of several to buy. Even the power transformer can be replaced with a model from the universal lines, or even one salvaged from an old tube-type TV set.

In addition, take a close look at the electrolytic filter capacitors. Look for swelling, oozing liquid, dry powder-like (once liquid but is now dried) material at the ends of the units, and any telltale discoloration of the body of the capacitor. Also look at the metal can electrolytic capacitors for similar problems.

Even if none of them show signs of damage or fatigue, it is a good idea to replace the electrolytic capacitors in old equipment. Electrolytic capacitors just don't store well. The symptoms of a bad electrolytic in the power supply are a hum or buzz on AM, and a raucous buzzing and chirping CW signal. (If your RST report is 574, then suspect a problem!)

Also check the general construction of the unit. Many of those transmitters were sold in kit form only, or as both kits and factory-built units. Remember that many of those rigs were for novices



Before purchasing old equipment of any type, it's best to check out its innards. Pay particular attention to the electrolytic capacitors and the power transformer.

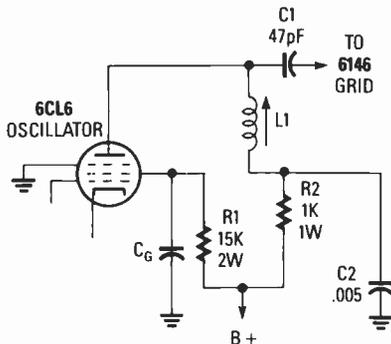


Fig. 1. Here's a partial schematic diagram of the crystal oscillator in the DX-60B. After many years in storage, the slug in L1—the tuned coil—had changed somewhat and the coil was no longer resonant.

whose experience level was minimal—the construction often reflected that fact.

Before tuning the rig on, spray the controls and switches with a contact cleaner. Work the controls vigorously to force the cleaning action. The reason for doing that is that many malfunctions are actually caused by dirty control or switch contacts. In many cases, pre-cleaning not only eliminates useless troubleshooting—looking for problems that don't exist—but in a transmitter, it could mask a fatal fault. For example, is the apparent lack of grid current due to a faulty meter switch, or a lack of drive current from the oscillator?

Trial By Fire. Now comes the *big smoke test!* Connect the transmitter to a dummy load and RF wattmeter. If you do not have those instruments, then "wing it" the way we did in the 1950's; use a 75-watt electric light bulb as the load...its brightness will tell you how much RF is being produced. A short piece of coax can be used to connect a light socket to the rig.

Make sure that a crystal is inserted into the socket. If more than one socket is available, make sure that the crystal (XTAL) switch is set for the socket that is occupied by a crystal. Alternatively, make sure that the VFO is installed correctly. A telegraph key should be connected to the KEY jack.

Select a band that matches the crystal; harmonics of 7-MHz are used on 14-MHz and above. The desired frequency is divided by 2 on 20-meters, by 3 on 15-meters and, by 4 on 10-meters.

If the rig has a tune position on the FUNCTION switch (the DX-60B does), then set the rig to tune. Also set the METER switch to grid. That setting disables the

final amplifier tube to permit the final amplifier input stage to be tuned. If there is a DRIVE LEVEL control (as on the DX-60B), adjust the control for a maximum grid current of 2.5 mA if only one final tube is used, or 5 mA if two are used.

Next, turn the FUNCTION switch to CW, and the METER switch to plate. The LOAD control should be adjusted to the position in which the capacitor plates are fully meshed, and the TUNING control to either its mid-point or the approximate band markings on the front panel.

Key the Rig. The meter should read plate current. Quickly adjust the TUNING control for minimum plate current. When the TUNING control is properly adjusted, the RF output (lamp brightness) goes up. Advance the LOAD control a little and then re-dip the TUNING control. The lamp should become slightly brighter. Alternately, advance the LOAD and re-dip the TUNING control until the maximum plate current is reached. For a single 6146, use about 125 mA, for a single 807 or 1625 final-amplifier tube, use about 115 mA. Double those figures if two tubes are used.

Now you are ready to go on the air. Or should be. In the case of the DX-60B that I resurrected, the rig failed to key sometimes. When that happened, the grid drive failed (which could kill the final amplifier tube), indicating that the problem was the oscillator. After a lot of head scratching, I found the problem.

Figure 1 shows a partial schematic diagram of the crystal oscillator in the DX-60B. Inductor L1 is a slug-tuned coil. After many years in storage, the slug had changed somewhat, and the coil was no longer resonant. The slug still had the range, however, so I readjusted it until the rig keyed reliably. The coil's misadjustment was causing the oscillator to fail to turn on sometimes.

Those old novice and general transmitters of the 1950's and early 1960's may not have been indestructible, but they came close. Resurrecting them is not difficult, and is a good way to get on the air cheaply.

Well, we've used up the space allotted to us for this month, but be sure to tune in again next month when we'll chat more on this interesting topic. Until then, if you have any tips, comments, or suggestions for this column, send them to *Ham Radio*, **Popular Electronics**, 500-B Bi-county Blvd., Farmingdale, NY 11735. ■

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ANTIGRAVITY

(Continued from page 37)

into the hole in the other piece of wood (as shown in Fig. 2). Now using a 1/2-inch thick piece of plywood as a base, attach the piece of wood (using screws or glue) containing LED1 to the base and hook up the transmitter circuitry.

Next attach the other piece of wood, containing the solar cell, to the base. Attach a voltmeter to the solar cell, and align the piece of wood containing the solar cell with the one containing LED1, adjusting the two framing pieces until you get the maximum voltage reading—about 0.2 volt. Once properly aligned and focused, apply some wood glue to the bottom side of the wood that has the solar cell, and let it dry without moving the wood.

Once the first upright secured in position, place the second upright on the base board, moving it around to find the optimum position. Once the proper position is located, secure the second upright in place with glue or screws.

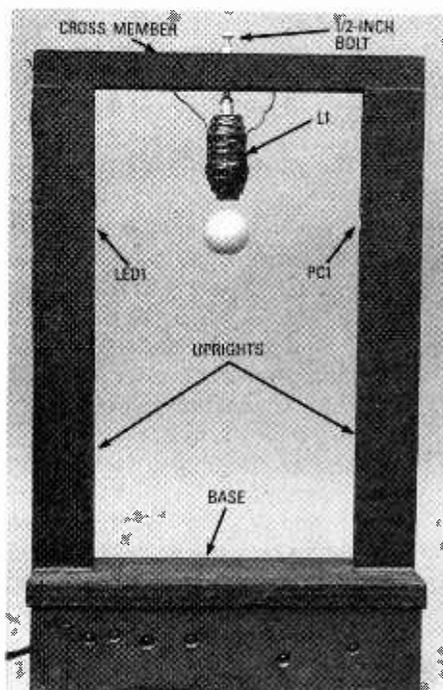
After securing the two uprights, cut a 1 x 1-inch piece of wood (the cross brace) to a length to fit across the top of the two uprights. Drill a 1/2-inch hole directly in the center of the cross brace to fit the bolt that serves as the core of the electromagnet. Then attach the cross brace to the top of the uprights with screws or glue.

Thread the bolt through the cross brace, and screw a 1/2-inch nut onto the top of the electromagnet's bolt to hold it in place. The cross brace, like the two uprights, has a hole drilled lengthwise through the center to provide a duct for the wires of the electromagnet. You may, if you choose, tape the wire to the outside of the frame.

Now interconnect the three circuit boards, as shown in Fig. 1. Connect PC1, LED1, and L1 to the appropriate points in the circuit and you are nearly done.

The Magnetic Ball. A light, hollow plastic ball is used as the floating sphere in this project. It must be opaque (not able to pass any light) or it will be useless because the proper operation of the circuit depends on the ability of the ball to block IR emissions. The author used a ping-pong ball.

A hole is cut (drilled) in the ball and a permanent magnet is glued inside. The magnet must be fairly strong, yet



When the Anti-Gravity Generator is completed, you can sand and paint or stain the frame to improve its appearance.

small in size. A source for such a magnet is given in the Parts List. The prototype of the magnetic ball has two such magnets glued inside. If the electromagnet is at a polarity that opposes the polarity of the magnetic ball, the unit will not work. The ball will tend to roll over and fall. So if that is the case, reverse the wires of the electromagnet to remedy that condition.

Operation. With the unit powered up, the electromagnet should be at full power, with the transmitter and the receiver not blocked. Test the project by placing a small screwdriver or any magnetic material near the electromagnet. The electromagnet should attract it and when the IR receiver is blocked, the screwdriver should fall.

If all is well, position the electromagnet so that it is located just about 1 inch above the transmitter and receiver, and slowly move the ball up toward the electromagnet. There should be a point where the ball will float by itself.

Troubleshooting. If the ball opposes the electromagnet, reverse the wires of the electromagnet. If the ball is drawn toward the electromagnet too quickly, raise the position of the electromagnet. If the ball shows no response near the transmitter and

receiver, lower the electromagnet, until a response occurs.

Room lights may effect the unit. A simple diaphragm could be fabricated from tape and placed so that it shields the edges of the solar cell. That cuts down on the room lights that can hit the solar cell. The wider the receiver and transmitter are apart, the more likely it is that ambient light can effect the unit.

It may take a bit of experimenting with the adjustment of the electromagnet's position and with the aperture of the receiver, using black tape to control the ambient light hitting the solar cell in the receiver unit, in order to get the unit to function properly.

Make sure the infrared transmitter and receiver are in alignment. If you are using lenses, make sure that they are in focus. Focusing the lens helps to keep the beam as thin as possible. The plastic ball must be opaque and as light-weight as possible. ■

CIRCUIT CIRCUS

(Continued from page 87)

Sound-Activated Switch. In our final circuit, the power FET is used as a switch in a sound-activated cassette-recorder circuit; see Fig. 7. Such a circuit might find application in a project for recording intermittent noise or wild-life sounds automatically without having the recorder running constantly.

A sensitive electret microphone picks up the sound and feeds the signal to a two-stage amplifier circuit, consisting of U1-a and U1-b. The amplified output of U1-b is fed to a voltage-doubler circuit (made up of D1, D2, C4, and C5). The output of the doubler is input to the gate of Q1. When the DC voltage reaches the gate's threshold level, Q1 switches on, starting the recorder.

The cassette's internal or external microphone can be used to record normal sound levels, but for picking up weak sounds use the amplified output for a boosted level. Resistor R6 sets the circuit's sensitivity and should be experimented with to obtain the optimum adjustment.

That's all the time and space allotted to us for this month, but be sure to tune in again next month, when we'll present another group of fun circuits designed to entertain and educate you in the ways of electronics. So until then, don't fret just reach for a power hexFET. ■

LIGHTS ON

(Continued from page 34)

Once you've obtained the parts outlined in the Parts List, assemble the project using Fig. 3 as a guide. When installing the semiconductors, be sure to observe the proper polarity.

To check the circuit's operation, connect either point "H" or "P" to the positive terminal of a 12-volt DC source and connect "I" to the same terminal. Adjust the volume to suit.

After completion, the board can be mounted in an enclosure or coated with plastic spray and wired directly to the auto's parking-light, headlight, and ignition circuits. If the circuit is mounted in an enclosure, a cutout should be made for the terminal strip,

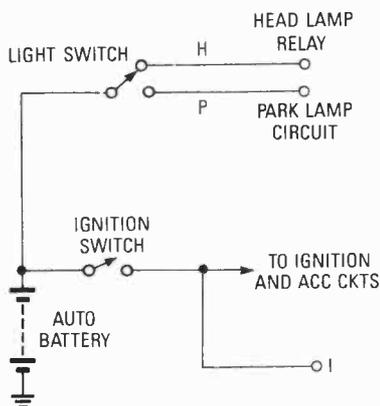


Fig. 4. Before installing the Light Warning System in your auto, first determine whether a Zener diode must be included in the circuit (see text for details).

and a few small holes should be drilled in the bottom to allow sound from the piezo buzzer to escape.

Installation. Refer to Fig. 4 for details on connecting the circuit to your automobile. The pad marked "I" is connected to the vehicle's ignition lead (at some point after the ignition switch). The pad marked "H" connects to the headlight power line, and "P" goes to the parking-light line.

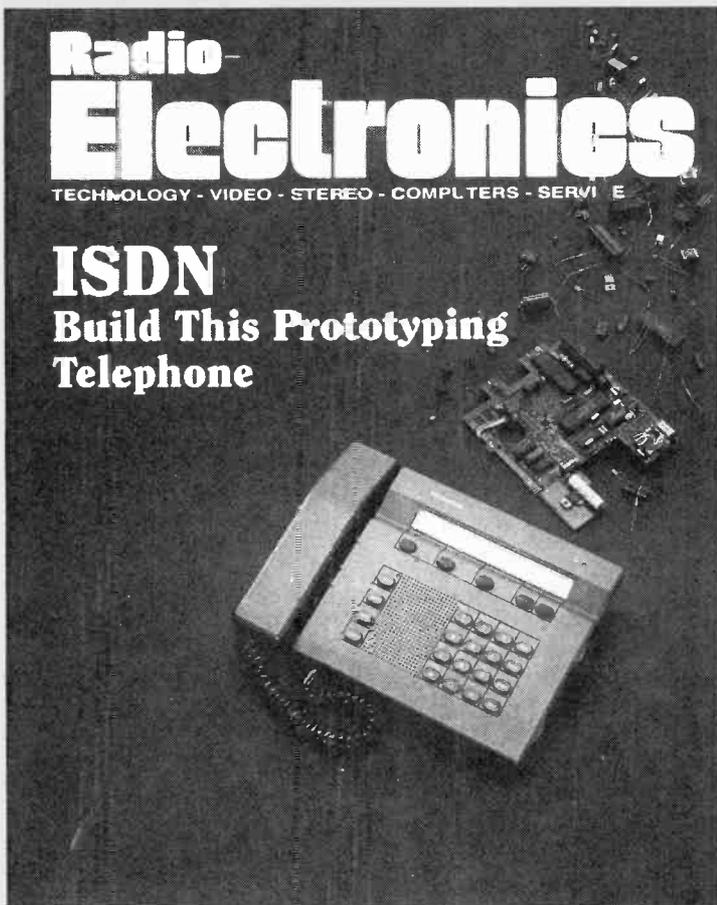
The wires are easily attached without disrupting the vehicle's wiring by using parallel splice connectors (available as Radio Shack part No. 64-3052). Once connected and checked, the unit can be mounted to the fire wall or inside the dash with double-sided tape or velcro strips. To allow the lights to be used with the ignition off without sounding an alarm, a single-pole single-throw (SPST) switch can be connected in series with D3 to defeat the alarm. ■

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MEGAMATE DISK

(Continued from page 38)

disconnected in our installation because it was restricting the movement of the housing.)

Turn the computer on and notice that the computer operates as it did before. Up to this moment your computer does not even know that a change has taken place.

Software. The installation of Megamate software is a snap. Boot up your computer and insert the Megamate software floppy diskette into drive A. Then make sure your system has the DOS prompt "A>" before you proceed.

Run the MEGAPREP program by typing "megaprep" and hitting the <Enter> key. Follow the simple instructions given by the program on the screen. The Megamate software is now installed on your DOS system diskette. Don't worry about the floppy or hard-disk configuration of your system—the software will ask significant questions and take the configuration of your system into account. Once the procedure is completed, remove the Megamate software diskette and put it in a safe place. Either power the computer off and then on, or do a warm boot (simultaneously press the <Ctrl>, <Alt>, and keys).

When the computer is powered up, a message will appear on the screen to tell you the Megamate driver letter. It will read:

The following Megamate drive is available:
Drive D: - 3.5 inch High Capacity

and, in this case, you would refer to Megamate as drive D, when accessing it via any software packages. You can check the 3.5-in. diskette drive letter anytime by entering the MMDRIVES command. That command will cause the drive letter message to be printed on the screen. About this time the user will begin to notice the quiet operation of the drive.

Formatting. There are two popular 3.5-inch diskette formats for IBM and compatible computers. One is the 720KB format, which is used by the IBM laptop computer and several other laptops. The other is the 1.4MB high-density format introduced on the IBM PS/2 model 50 and higher-level models.

The Megamate system will automati-

cally sense the format of the diskette used, whether it is 720KB or 1.4MB, and will adjust itself accordingly. The only time the user has to select a format is when initializing a new blank diskette.

Software is provided by the Megamate after the MEGAPREP program has been run. To format a blank diskette, place it in the D drive and at the DOS prompt type MMFORMAT D:720, or just MMFORMAT D:, which will default to the 1.4MB format.

What if...? Something could possibly go wrong. Our installation went smoothly, but your's may not. If the system fails to work, rerun the MEGAPREP program again. Maybe one of your answers was incorrect. If the problem persists, the manual alerts the user to address jumper settings on the card. The factory setting should cover almost all of the possible configurations used, but two other settings are available just in case a problem arises. For example, the factory setting activates I/O port 360h-367h. The other two ports are 3F0h-3F7h and 3E0h-3E7h.

MicroSolutions includes a text program on the software diskette, MEGAPRINT.ME, which tells of two problems, one each with the AT&T PC 6300 system and Hyundai Super 286C system, that can be software corrected in moments. Also, a troubleshooting index in the manual offers significant assistance to Megamate users. That index is complete, however, should the user be unable to eliminate the problem, Megamate offers technical support over the telephone.

The Advantages. It is obvious that the Megamate extension card, cable, and drive assembly are of the highest quality. The design made installation simple. The software was well planned and assured the basic neophyte of success in the application of it. The manual was brief and short, yet complete providing the information a user would require. If the user requires the ability to read either 720KB or 1.4MB diskettes, the Megamate does the job well.

Megamate 3.5-inch disk-drive system is available from MicroSolutions, Inc., 132 West Lincoln Highway, DeKalb, IL 60511 and sells for \$349.00. MicroSolutions offer a one year parts and labor warranty. For more information about the Megamate, contact the company directly or circle No. 63 on the Free Information Card. ■

ANTIQUE RADIO

(Continued from page 89)

tric Library Volume 9 (1949 edition). If anyone has one or more of the other eleven volumes in this set, Eric would like to hear from you.

Richard Spratley, one of the people who identified the Philco microphone in *A Flick of the Switch*, wrote that he enjoyed reading about the Philco "thingumajigs" and enclosed a picture and description of a "thingumajig" of his own.

Since several readers have asked me to include more mysteries in the column, I'm going to run the photo and hold back the explanation. Can any of the more astute gadgeteers in the crowd figure out what Dick is up to here? If you're not sure what's going on, send in a good creative guess—the wilder the better! I'll acknowledge all responses, and print the answer, in a future issue. One hint: the antique-looking object at the left is a crystal set.

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This illustration of the Philco Phone came from a photocopy of an advertising brochure contributed by Antique Electronic Supply Co.

Reader Restorations. Several readers have sent in very nice shots of sets that they've acquired and/or restored. I have room for just a couple of them this month, and plan to run more in the next issue. Among the several pictures sent in by Randy Eppmeh (Rt. 2, Box 621, Camden, AR 71701) is that of a very fine Crosley Model 148CP. Since that radio's original cabinet was too far gone to restore, Randy designed and built a special one for it. Quite an impressive piece of craftsmanship!



Reader Catto's workbench is almost as cluttered as my own, but his Zenith 7S529 restoration looks like a first-class job.

Randy would like very much to get his hands on a schematic for the set. Please write him if you can help.

Bob Catto (Chicago Heights, IL) sent a long and interesting letter telling me about some of the favorite radios in his large and varied collection. He enclosed a shot of a corner of his workbench, featuring a Zenith 7S529 now under restoration.

The set itself didn't need much work, but the cabinet required a lot of attention. Most of the original finish was gone on both the wood surfaces and the metal dial bezel. Just the kind of project I hate, but Randy has worked wonders with it. Look for more reader "show and tell" items next month!

Information Wanted. I've accumulated quite a backlog of letters from readers looking for information on old sets. Let's look at two.

John Burch (5431 South View Dr., Louisville, KY) is working on a Zenith 8S154 he inherited from his grandfather and would like any information he can get on this model. As for John's question about where to get replacement grille cloth, Antique Electronic Supply should be able to solve that problem, too.

Dennis A. Ritzel (6505 Sefton Ave., Baltimore, MD) is restoring a Zenith 6S52 and wonders what it would be worth if he decides to sell it. Interested readers might want to write him, see if he still has the set in his possession, and make an offer. Dennis is also looking for manuals for a couple of pieces of test equipment made by Precision Apparatus Co. (Glendale, NY): Sweep Generator Model E-400 and Marker Generator Model E-200-C.

See you next month. In the meantime, I'll be looking forward to hearing from you! Address your correspondence to *Antique Radio*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

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E-Z MATH

(Continued from page 84)

Solve the first equation for Y in terms of X:

$$2X + Y = 6$$

$$Y = 6 - 2X$$

Solve second equation for X:

$$3X - 3(6 - 2X) = 0$$

$$3X - 18 + 6X = 0$$

$$9X = 18$$

$$X = 2$$

Solve for Y with the second equation:

$$3X - 3Y = 0$$

$$3(2) - 3Y = 0$$

$$6 - 3Y = 0$$

$$-3Y = -6$$

$$Y = 2$$

8. Solve the first equation for X:

$$3X - 2Y = -21$$

$$3X = -21 + 2Y$$

$$3X/3 = (-21 + 2Y)/3$$

$$X = (-21 + 2Y)/3$$

Solve the second equation for X:

$$5X + 4Y = -13$$

$$5X = -13 - 4Y$$

$$X = (-13 - 4Y)/5$$

Set the two equations equal and solve for Y:

$$(-21 + 2Y)/3 = (-13 - 4Y)/5$$

To get rid of the fractions, multiply both sides by 15 (5 × 3):

$$15(-21 + 2Y)/3 = 15(-13 - 4Y)/5$$

$$5(-21 + 2Y) = 3(-13 - 4Y)$$

$$-105 + 10Y = -39 - 12Y$$

$$10Y + 12Y = 105 - 39$$

$$22Y = 66$$

$$Y = 3$$

Solve for X in the first equation:

$$3X - 2Y = -21$$

$$3X - 2(3) = -21$$

$$3X - 6 = -21$$

$$3X = -21 + 6$$

$$3X = -15$$

$$X = -5$$

9. Here is the solution using the previously given five steps:

- 1) See Figs. 5 and 6.
- 2) See Fig. 6.
- 3) $I_1 R_1 + I_2 R_2 = V_{S1}$
 $I_3 R_3 + I_2 R_2 = V_{S2}$
 $30I_1 + 40I_2 = 6$
 $60I_3 + 40I_2 = 12$
- 4) $I_2 = I_1 + I_3$
- 5) Substitute $I_1 + I_3$ for I_2 in the first loop equation:

$$30I_1 + 40I_2 = 6$$

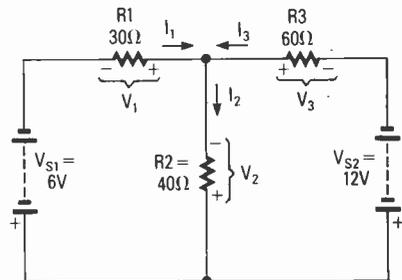


Fig. 6. This is a revised version of Fig. 5 with the branch currents and voltages with polarities in place.

$$30I_1 + 40(I_1 + I_3) = 6$$

$$30I_1 + 40I_1 + 40I_3 = 6$$

$$70I_1 + 40I_3 = 6$$

Substitute $I_1 + I_3$ for I_2 in the second loop equation:

$$60I_3 + 40I_2 = 12$$

$$60I_3 + 40(I_1 + I_3) = 12$$

$$60I_3 + 40I_1 + 40I_3 = 12$$

$$40I_1 + 100I_3 = 12$$

We must solve those equations for I_1 and I_3 . Solving for I_1 :

$$70I_1 + 40I_3 = 6$$

$$70I_1 = 6 - 40I_3$$

$$I_1 = (6 - 40I_3)/70$$

Put this value in the second equation and solve for I_3 :

$$40I_1 + 100I_3 = 12$$

$$40(6 - 40I_3)/70 + 100I_3 = 12$$

$$(240 - 1600I_3)/70 + 100I_3 = 12$$

$$3.43 - 22.86I_3 + 100I_3 = 12$$

$$77.14I_3 = 12 - 3.43 = 8.57$$

$$I_3 = 8.57/77.14 = .111 \text{ amps}$$

Now, find I_1 :

$$70I_1 + 40I_3 = 6$$

$$70I_1 + 40(.111) = 6$$

$$70I_1 + 4.44 = 6$$

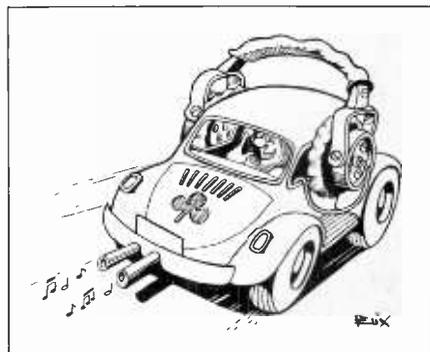
$$70I_1 = 6 - 4.44 = 1.56$$

$$I_1 = 1.56/70 = .0223 \text{ amps}$$

Now, compute I_2 :

$$I_2 = I_1 + I_3$$

$$I_2 = .0223 + .111 = .1333 \text{ amps}$$

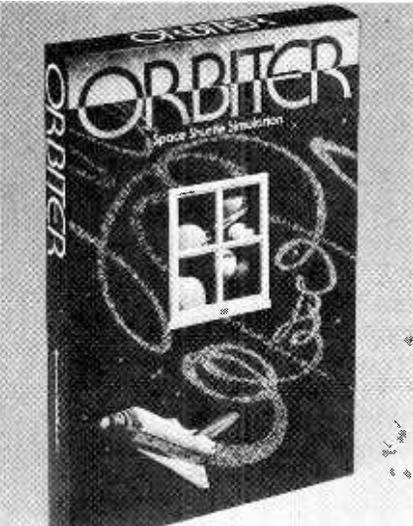


EXECUTIVE DIVERSIONS

(Continued from page 65)

All this fun isn't really free, of course. GENie charges about \$5 per hour, while CompuServe charges about \$6.30 an hour, with a premium for 1200 baud or higher speed modems. Most services have local telephone-access numbers in and around major cities, but they're not available everywhere so you may have to add in long-distance charges as well. Also, Some local BBS's have the capability of supporting on-line games, adding to the fun (and the cost).

In addition, a few IBM PC computer games provide modem support so



A reality-based vehicle simulation, Orbiter, is a very complex space-shuttle simulation. Orbiter's features include all of the phases of space flight, from countdown to landing.

that you can compete with another player on-screen at the same time. One such game is Sierra On-Line's 3-D Helicopter Simulation, which allows realistic two-player combat through a modem hookup.

Hard Facts. Thus far, we've looked at the highly competitive world of PC gaming software. However, don't get the idea that the PC is the only computer with a "light-hearted" streak. There are a lot of machines out there that are just as suitable, or more so, for games.

And not all PC's are created equal. Just because you own a PC doesn't mean that its cut out for fun and games. What makes a PC fit for work and play? What other machines make good playmates? Those are topics for next month. See you then!

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PE589

MAY 1989

SWL ANTENNA

(Continued from page 43)

pipe, and position the windings to evenly cover the pipe to the third one-foot mark.

Continue wrapping and taping until the full 7-foot winding has been completed. Wrap the end of the 7-foot winding extra securely because you are going to be making the connections at that end, and it's annoying to say the least, to have the winding loosen while you are splicing and soldering the ends together. If you've done everything correctly, the near and far ends will be together at the end of the pipe where you'll be making the connections.

Hooking it up. Here's where we start having fun. The basic connections are shown in Fig. 1. Strip about a half inch to an inch from the ends of each conductor at each end of the cable. Pair up the ends (check with an ohmmeter just to be sure). Take the first two conductors of the near end of the flat cable (going right to left, or left to right—it doesn't matter as long as you are consistent) and twist (splice) them with the first and fourth conductors of the far end of the cable to make connection A. Then, take the third conductor of the near end and splice it to the second conductor of the far end. Finally, take the fourth conductor of the near end and splice it to the third conductor of the far end. That leaves the last (fifth) conductor; the ends of that conductor are designated the B (far end) and C (near end) connections.

Solder the splices together and cover with electrical tape; if you want more flexibility for experimentation, skip the soldering and secure the splices with wire nuts. The last step is to make two cuts in the coils. Cut the first conductor (only) at the midpoint of the winding. Next cut the first and second conductors (only) at the point where the cable emerges from the pipe (at the far end), prior to the first turn of the windings. Once you've carefully made those cuts, you are set to connect the antenna to your receiver.

For the basic configuration, ground connection A, and attach a length of coax cable to B (center conductor) and C (shield). The length of coax acts as a capacitor and, in combination with coil B/C, forms a fixed-frequency wave trap or matching circuit, which is inductively coupled to the balance of

the antenna. It's a good idea to keep the length of coax between the antenna and receiver to less than 15 feet so that you won't have to worry about its impedance.

For experimenters, here are a couple of things to try: You can experiment with the capacitance in the tuning circuit by hooking external capacitors in series (to reduce capacitance) or parallel (to increase capacitance). And you can use variable units to form a versatile antenna-tuning circuit. You can also decrease the physical length of the antenna by decoupling sections. That can be done by breaking the splices in the conductors between the A and B/C connections of the antenna.

Finally, for those interested primarily in broadcast-band DX'ing, try the configuration shown in Fig. 2. That circuit connects the antenna's conductors in a trolley-car fashion for the maximum physical length. Start with the near end and designate the end of the first conductor as A. Then connect the second

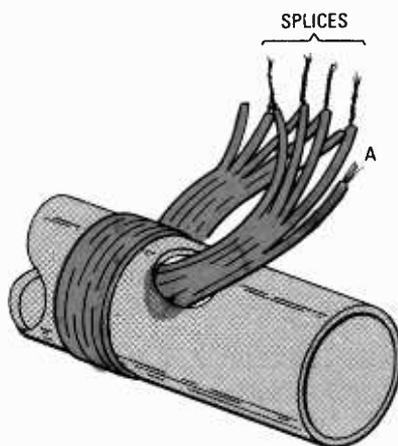


Fig. 2. Use these connections if your preference is broadcast-band DX listening. They put all 5 conductors in series for the maximum physical length.

conductor at the near end to the first conductor at the far end. Proceed in a like fashion until all splices are made. If you've done everything correctly, the last conductor at the far end will have no connection; just clip it off. Connect A to the receiver's antenna input, and you are done. Do not cut the coils for this version of the antenna.

As you can see, there's always plenty of room for experimenting with the Cliff-Dwellers SWL Antenna. And you don't have to worry about high-voltage power lines, or falling off a roof or out of a window while trying to erect the antenna. Even better, the antenna doesn't cost much to build. ■

COMPUTER BITS

(Continued from page 91)

BBS's, including Gemsback's own REBBS (516/293-2283). At the DOS prompt, type CORETEST HELP to get a summary of what the test does and how to run it.

If you can't locate a copy of CORETEST, you could time how long it takes to copy a large file to and from a freshly formatted disk. You needn't perform a high-level format (with DOS's FORMAT program) to measure DTR with CORETEST, but you will to measure copy times.

To change the IF, you must use software built into your disk controller or an external program; DOS's FORMAT program won't do it. Eight-bit XT controllers usually have the appropriate routines built-in, as do sixteen-bit RLL controllers for AT machines. MFM controllers for AT's usually don't have built-in format routines.

Usually you start the program by running DEBUG.COM, and when you get the prompt (which is a hyphen), enter G=C800:5. At that point you should enter some sort of menu-driven program. In any case, consult the installation guide for your disk drive and controller.

In the absence of ROM-based low-level formatting software, you can use *Disk Manager* (from Ontrack Computer Systems) for a Seagate driver, or *SpeedStor* (from Storage Dimensions), for most drives.

If you're interested in optimizing the performance of your machine, don't accept the manufacturer's default IF value; it's based on generalizations that may or may not fit your individual case. For example, the default IF for the 8-bit Western Digital controller in my XT is 3. But as the chart in Fig. 1 shows, I get four times the performance with an interleave of 4. On the other hand, *Disk Manager* wants to format my ST-251 with an IF of 3, but I get 50% better performance if I chose an IF of 2.

If you want to experiment with different interleave factors, do so before loading any software on your drive. If you want to experiment with a drive already in use, *back it up first just to be safe!* There is no way to recover data from a disk that has been low-level formatted.

After settling on an optimal interleave, you'll have to use FDISK and FORMAT; consult your DOS manual for details. ■

COMMERCIAL SW

(Continued from page 76)

overseas audience. Still, in practice, there usually is a substantial signal "footprint" that falls on the U.S. States.

Costello puts it more directly: "When you've got 3-million watts of effective radiated power crossing the United States on its way to Canada and Europe...I mean, if they want to listen, they listen!"

Carlson adds that a substantial portion of the nearly 5,000 letters KUSW received in its first half-year of broadcasting were from American listeners.

And Fricks notes that while the U.S. "is not our target and we don't beam to it," when potential advertisers ask—and they inevitably do—"our answer is, yes, there is a back-signal from WCSN that reaches most of the United States."

Though all three commercial SW stations are working hard at it, what is missing so far is the big breakthrough, the first of the "big name" advertisers—the soft drink "kings," the auto makers, the fast-food franchisers with worldwide networks of restaurants.

"The name *Christian Science Monitor* gets us in the door," Fricks says, "and when you talk to senior decision makers about advertising on what is basically a new medium there is real interest."

"The difficulty lies in trying to translate that excitement into some concrete steps that will lead to a benefit for both the advertiser and the broadcaster."

"We're working with a number of major advertisers," says Carlson, "and they are receptive to the idea. We haven't got them right now, but we expect to!"

In the short run, that means shortwave broadcasters, especially the smaller WRNO Worldwide and Superpower KUSW, must be more creative when it comes to producing revenues.

"We have to go about marketing shortwave in a different way than you do with AM or FM," Costello notes. "For instance, I have my own little mail-order business. We sell New Orleans Dixieland jazz records, an active antenna that amplifies our signal for people who live in apartments, converters for shortwave reception in your car, WRNO tee-shirts, and other listener-oriented products."

KUSW also is selling "shortwave radi- os, golf shirts with the station logo, key-

chains, stuff like that," Carlson says. But the Salt Lake City station, carrying the Sears-Roebuck-of-the-air gambit a step further, now has its own "Superpower KUSW Worldwide Catalog," which offers what Carlson calls "products unique to the American West."

WRNO Worldwide also "stumbled onto something else that has opened a whole other area of revenue for us," according to Costello.

Five years ago, the commercial shortwaver began carrying play-by-play coverage of the National Football League's New Orleans Saints on Autumn Sunday afternoons. Though they produce no direct advertising revenue, they drew listeners...and the attention of the athletic director of Louisiana State University.

With more than 75,000 alumni around the country, and the world, the station offered an effective way to reach that important group.

As a state-supported school, LSU could not buy airtime with taxpayers' money, but the alumni association pays WRNO from its funds to broadcast its college football games.

Two years ago, the University of Flori-

da, for similar reasons, contracted with the station to carry its football schedule for a fee.

"We're now beating on doors," Costello says. "Trying to sell this sports package of games to a beer or soft drink advertiser at a very attractive cost, to bring in more revenue."

Commercial shortwave radio "at the moment...is not a tremendous driving force," Jacobs admits, "but it is still in the fledgling stage. They're all still learning."

"I'd like to leave you with this," Costello says. "A year ago we got a call from Arbitron, the outfit that measures listening audiences. They wanted to know why a station in New Orleans kept turning up in its listener diaries in places from North Carolina to Chicago. They weren't aware we were shortwave."

"Now those responses haven't reached the point where Arbitron can give me an estimate of my listening audience, but still, it was significant."

"It's the first time that a shortwave station—long considered broadcasting's stepchild—ever managed to penetrate this barrier!" ■



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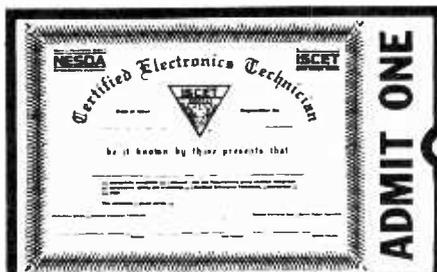
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Q MULTIPLIER

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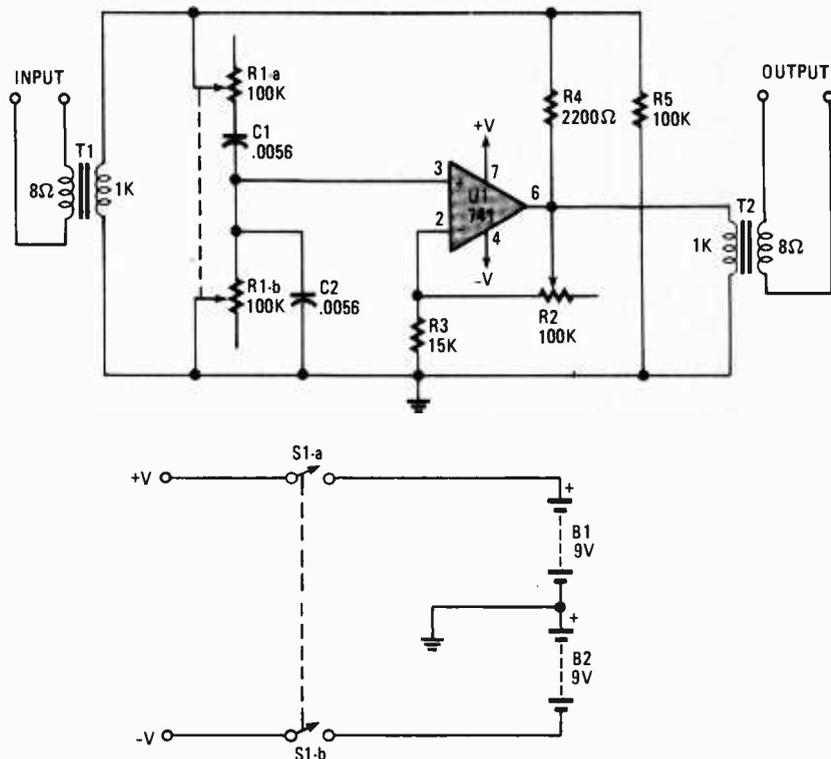


Fig. 1. The Audio Q-Multiplier combines two old-time circuits, the Q-multiplier and the Wein-bridge oscillator, to make an audio filter that's simple, but very effective. Potentiometer R1 sets the frequency while R2 controls the selectivity from wide-open to razor sharp. The filter will boost the performance of almost any receiver.

Finally, transformer T2 helps match the output of the filter to either a speaker or low impedance earphones. Other transformers may be substituted if you want to match the filter to different input or output impedances. Power for the circuit is supplied by two 9-volt batteries.

Construction. Since I wanted to use the Audio Q-Multiplier with "The Simplest Ham Receiver" from **Hands-on-Electronics**, June, 1988, I chose to build them both the same way: bread-board style. The integrated circuit is socket-mounted on a piece of perf-board and short lengths of hook-up wire are used to make connections to the rest of the circuit. The wiring is simply point to point. That is a good way to gain experience using IC's since you can try different component values or designs without resoldering each time you change something.

If you want, you can build the project to fit in a small plastic box and use a general-purpose board to hold most of the parts.

None of the parts values are especially critical, but C1 and C2 should

be of good quality (I used poly styrenes) and of equal value. Ceramic-disc capacitors are a poor choice.

Using the Filter. After double-checking the wiring, turn on the power and advance R2 until the circuit breaks into oscillation to make sure everything works. Back off R2 and adjust R1 to the frequency of a signal you want to receive, then use R2 to alter the selectivity as needed. The two controls interact somewhat, but a little practice will make tuning a snap. A fast way to tune in a signal is to put the circuit into oscillation and match the pitch of the filter to that of the signal, then reduce the feedback.

The Audio Q-Multiplier can be used in a wide variety of applications where a flexible filter is needed. It also makes a good general-purpose audio oscillator because its output is almost a pure sine wave when the feedback is adjusted to where it just begins to oscillate.

All-in-all, that's not too bad for a circuit you can build in an hour from a handful of parts.

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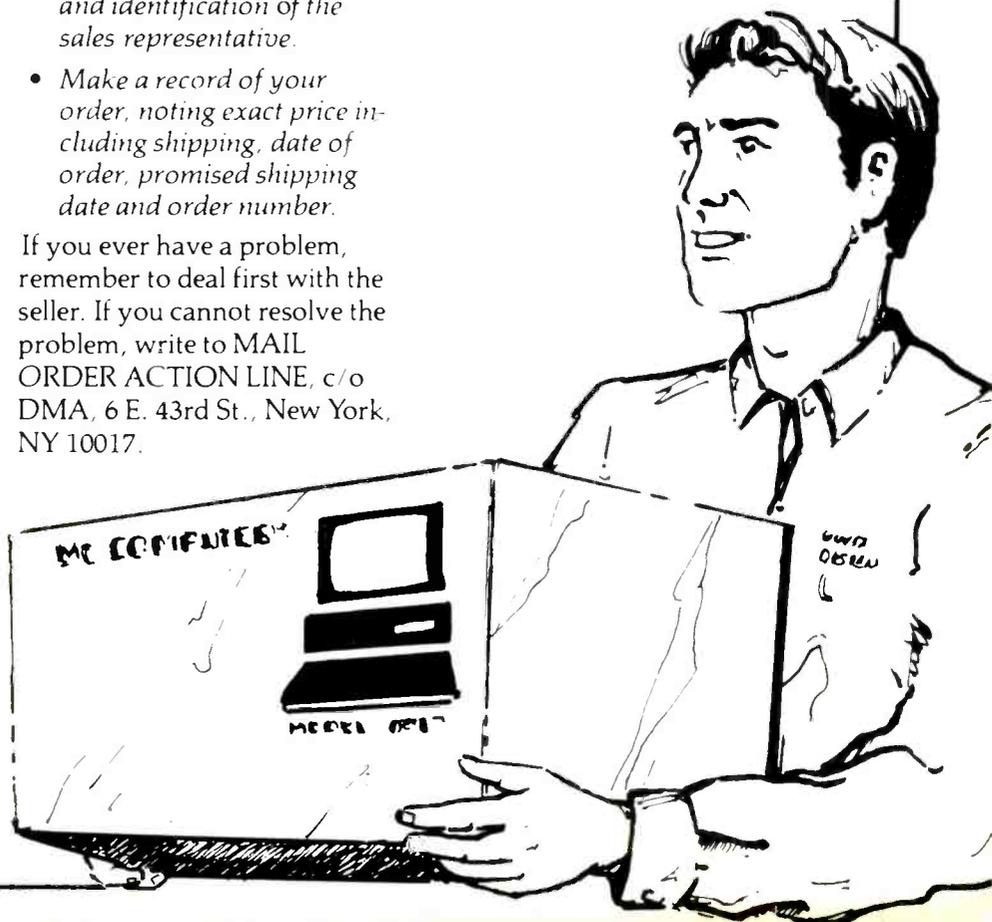
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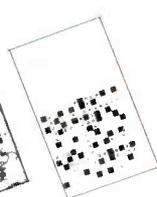
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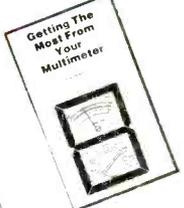
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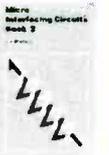
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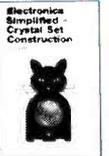
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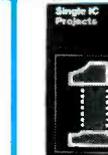
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